THE QUALITY AND COST IN TIME AND MONEY OF ANGEL FOOD CAKES PREPARED USING INDIVIDUAL INGREDIENTS AND A COMMERCIAL MIX

by

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INTRODUCTION

The use of commercial mixes has increased greatly in the last five years. Today practically any baked product can be purchased in mix form. It is important for modern homemakers to consider the amount of time and money they spend in food preparation in relation to the quality of the food which they produce.

Some research has been done comparing several baked products made from mixes with products made from individual ingredients. In these studies the cost in time and money and the acceptability of the products have been determined. In some instances the data indicated that the more acceptable products were obtained with individual ingredients, and in others the better products were obtained from the commercial mixes. No study of this type was found in the literature concerning angel food cakes. Therefore, it was deemed worthwhile to conduct a study to compare the quality and cost, in time and money, of angel food cakes prepared from individual ingredients and a commercial mix.

REVIEW OF LITERATURE

Studies Related to the Use of Mixes

Paul et al. (1954) reported a study comparing the palatability, preparation time, and cost, of yellow and white cakes that were fresh, baked from frozen batters, and made from mixes. Yellow cakes tested when fresh were the most palatable; whereas white cakes made from a commercial mix were judged the most palatable. Yellow cakes made from commercial mixes were the

least palatable; whereas the frozen batter cakes were judged the least palatable of the white cakes. Cakes made from the commercial mix were reported to take the least preparation time and frozen baked cakes the most time. The home-prepared mix was the least expensive for the yellow cakes, but the fresh white cake was the least expensive. The commercial mix was the most expensive for the yellow cake, and the home-prepared mix for the white cake.

A basic devils food cake recipe was compared with a devils food cake mix by Morr (1951). The mixes were reported to cost less than the basic recipe. Outside of a few minutes to measure ingredients for the basic recipe there seemed to be little difference in the time involved to prepare the cake and the mix. Cakes made from the mix were said to taste alkaline.

A series of experiments were related by Hermance and Snow (1958) that determined the palatability and cost of chocolate cakes made from mixes and those prepared from individual ingredients. The cakes were made from five commercial mixes and also from eight recipes using the conventional and dump methods of mixing. A taste panel of five members scored the cakes for color, moisture, texture, and flavor. The cakes prepared from mixes dried out rather quickly and had a stale flavor after either six weeks of storage in the freezer, or 48 hours at room temperature. These changes were not noticeable in cakes made from recipes. The preparation time was 38 minutes by the dump method, and 20 minutes for the mix. Cleanup time was greater for the cakes prepared from recipes than for those prepared from mixes. The cost

of the recipe cake was $0.43; for the mix cake calling for added eggs, $0.39; and for the mix with added milk, $0.41. It was suggested that the cakes were higher in quality when made from recipes, but cost more in time and money than mixes.

Asp et al. (1957) reported a pilot study of the money and time spent in making yellow cakes, chocolate chip cookies, biscuits, and pie crust by homemakers using individual ingredients, homemade mixes, and commercial mixes. Homemakers prepared a product three times and recorded their preparation and cleanup time. After each product was baked, it was weighed by the project leader, who recorded the yield and cost data, and collected the record forms. The cost per recipe for the products made from individual ingredients and homemade mixes differed only slightly, but those from the commercial mixes were the most expensive. Cakes prepared from individual ingredients cost $0.334; homemade mix, $0.325; and commercial mix, $0.407. Cookies prepared from individual ingredients cost $0.307; homemade mix, $0.288; and commercial mix, $0.441. Biscuits prepared from individual ingredients cost $0.086; homemade mix, $0.077; and commercial mix, $0.128. Pie crust made from individual ingredients cost $0.048; homemade mix, $0.045; and commercial mix, $0.085. The time to make the homemade mixes was excluded from the calculation of total preparation time. For all products, the time required to prepare the homemade mixes was shorter than that required to prepare the same product from the individual ingredients. The time necessary to make the products from commercial mixes was about the same as the time to make them from homemade mixes. However,

chocolate chip cookies made from the commercial mix took less time than the cookies made from the home-prepared mix. Cakes prepared from individual ingredients required 27 minutes total time; homemade mix, 33 minutes; and commercial mix, 18 minutes. Cookies prepared from individual ingredients took 27 minutes; homemade mix, 26 minutes; and commercial mix, 13 minutes. Biscuits prepared from individual ingredients required 18 minutes; homemade mix, 19 minutes; and commercial mix, 13 minutes. Pie crust prepared from individual ingredients required 17 minutes; homemade mix, 16 minutes; and commercial mix, 13 minutes.

Experimental work done in the course, Consumer Buying of Food, at Michigan State College was discussed by Morr (1951). Pastry was baked from several mixes and from a basic recipe made with lard and with hydrogenated fat. Basic pastry made with lard cost $0.10; pastry made with hydrogenated fat cost $0.13; and pastry from a commercial mix, $0.17.

The cost of basic apple pies using lard and hydrogenated fat was compared with the cost of an apple pie mix, commercially frozen pie, and commercial bakery pie. The basic apple pie prepared with lard cost $0.44 and with hydrogenated fat, $0.47. The pie made with apple pie mix cost $0.39. The commercially frozen pie cost $0.69 and the commercial bakery pie, $0.75. The class tasted and compared the pies. They reported that the pastry of the apple pie mix was not as flaky as the pastry made from individual ingredients, and the apples in the pie mix did not have much flavor. The class commented that the bakery pie and frozen

pie were not enough better than the other pies to warrant the high prices (Morr, 1951).

Freeman (1951) stated that in an institution, commercially prepared pie crust mixes were easy to use and saved time. Also, she found that mixes of dry ingredients made up in quantity before they were used saved time and labor. Mixes used in restaurants were reported by Cline (1949) to reduce preparation time as much as 66 percent, and in some cases to cost less than products made from individual ingredients. Prepared biscuit mix was suggested as a time-saver for institutions. It was related in an anonymous article (1951) that for institutional use, mixes produced products of as high a quality as basic formulas.

Factors Affecting the Quality of Angel Cakes

A good angel cake should have an even grain with small to medium sized cells and thin cell walls. Also, it should be tender enough to give the impression of melting in the mouth, and have a delicate flavor and inviting odor. Platt (1931) described the texture of angel cake when he stated,

> Texture is an expression of elasticity, softness, pliability, smoothness, or silkiness of the crumb. It may be determined by a sense of touch or by the physical condition of the crumb, and to a minor degree by the grain. Speaking in physical terms, texture is a combination of compressibility, elasticity and tensile strength.

According to Justin et al. (1956), p. 371, a good angel cake is, "symmetrical in shape, evenly and slightly rounded, and delicately browned. The crust is tender, but not sticky. The texture is silky, tender, moist and resilient. The grain is fine and

uniform." Sweetman and McKellar (1954), p. 418, stated "Angel food cakes should be light, tender, and easily pulled into pieces. A cross section should show uniform, medium-sized cells." In Practical Cookery and The Etiquette and the Services of the Table (Department of Foods and Nutrition, 1956), p. 190, the members of the Department of Foods and Nutrition at Kansas State College defined a good sponge cake as having a golden brown crust, fine texture, and as being moist and tender, and light in weight for its size.

The Ingredients and Their Proportion. The ingredients used in the preparation of angel cake are egg white, salt, cream of tartar, sugar, flour, and vanilla. The egg white is the ingredient that gives the cake its volume and character. The quality of the foam is affected by the quality of the egg, its treatment, and by the other ingredients and their proportions (Lowe, 1955, p. 360).

The effect of the addition of salt or sugar on the physical characteristics of egg white and upon denaturation of egg white protein was determined by Hanning (1945). Foams containing salt were more crumbly and less plastic than those containing sugar, or those with neither salt nor sugar. The salt seemed to hasten the coagulation of the protein in the egg white, whereas sugar delayed coagulation and required a longer beating period. Salt is added to angel cakes to enhance the flavor.

Cream of tartar in angel cake tenderizes, whitens, and stabilizes the foam. Cream of tartar acts to tenderize by peptization of the egg and flour proteins. Hughes (1955), p. 394, stated

that cream of tartar bleaches the flavone pigments of the flour helping to produce a white cake. Cream of tartar also stabilizes the foam so that heat may bring about coagulation before the foam collapses and produces a coarse texture in the cake. Shrinkage during baking and cooling also is lessened by the use of cream of tartar. The optimal proportion recommended by Hughes (1955), p. 394, was one teaspoon cream of tartar per cup of egg whites. Barmore (1936) further indicated that the whites of fresh eggs should be beaten with potassium acid tartrate to produce a white, tender cake. He found that different acids had varying effects on the quality of angel cakes. Acetic or citric acid prevented extreme shrinkage, but did not produce cakes of as fine a texture as potassium acid tartrate. Potassium acid tartrate also lessened shrinkage. It was suggested that the acid acted to stabilize the foam by acting on coagulating or coagulated protein. Lowe (1955), p. 350, ascertained that the addition of too much acid could be detrimental to foam formation, because acid peptizes the protein and delays coagulation. Grewe and Child (1930) also found that angel cake prepared with acid potassium tartrate was white and fine grained, whereas without it the cake was coarse grained and yellow. Acid potassium tartrate increased the hydrogen ion concentration in the cake, and it was concluded that the change in grain and color resulted from the increased acidity.

Sugar stabilizes and tenderizes egg white foam and contributes to flavor. Lowe (1955) explained that sugar delays the coagulation of the egg proteins and has a tenderizing effect on the foam. The coagulation of the egg proteins is delayed because

of the peptizing action of the sugar on the proteins. She gave the optimum amount of sugar as one gram per gram of egg white, and stated that cakes with large proportions of sugar have dry, sugary crusts. Justin et al. (1956), p. 372, pointed out that when the proportion of sugar is increased over that given in a standard recipe, a sweeter more tender cake is produced, but the cake has a tendency to fall and to have a sugary crust.

Flour is used to bind together the ingredients of the cake. Lowe (1955), p. 362, reported that cake flour produces a cake of higher quality than all-purpose flour. For example, cakes prepared from all-purpose flour are more compact and of smaller volume than those prepared from cake flour. Hughes (1955), p. 394, contended that flour gives stability to the cake crumb, and as the sugar is increased the flour also needs to be increased to give a satisfactory ratio of flour to sugar. It was suggested that the optimum proportion of flour per gram of egg is from 0.2 to 0.4 grams (Lowe, 1955, p. 362). This proportion of flour to egg gives a tender, moist product; whereas a larger proportion of flour to egg gives a drier less tender cake.

Vanilla is used to enhance the flavor of the angel cake.

Quality and Age of the Eggs. Since 1925 the quality of eggs has been determined by the United States Department of Agriculture through its official egg grading program (U. S. Dept. Agr. Bul. 26, 1954). Official grading means separating the eggs into grades based on individual quality and weight per dozen. The grades used are U. S. Grade AA, U. S. Grade A, U. S. Grade B, and U. S. Grade C. The six U. S. weight classes and the minimum

weight for each in ounces per dozen are: jumbo, 30 oz.; extra large, 27 oz.; large, 24 oz.; medium, 21 oz.; small, 18 oz.; and peewee, 15 oz.

The grader first observes the condition of the shell. An odd-shaped, dirty, or cracked egg is placed in a lower grade than eggs with clean, smooth shells. The interior quality of the egg is examined before a candling light. The size and condition of the air cell; the size, position, and shape of the yolk; and the amount of thick white are the factors noted. Some eggs are broken out of the shell and are compared with standards for broken out appearance. Eggs may be sorted for size on the basis of weight as they are candled (U. S. Dept. Agr. Bul. 26, 1954).

Tests for determining the quality of eggs that are used in the laboratory were described by Brant et al. (1951). The yolk index was defined as "the ratio of the height to the width of the yolk measured after the yolk had been separated from the albumen." These authors stated that the yolk index did not seem to be a determining factor in the appearance of opened eggs. The albumen index, "the ratio of the albumen height to the average width of the firm albumen," was the second test described. This test could not be used with the USDA chart, picturing the USDA grades for opened eggs, because there was no uniform scale for comparison. The albumen area index is an estimate of the observed spreading of the thick albumen. This index was not considered to be related to appearance quality except as an indication of deterioration in storage experiments. The Haugh unit, determined from the height of the thick white and the weight of the egg, was found to conform

with U. S. standards, and was regarded as an acceptable laboratory test to be used with the USDA egg grading chart.

Harns et al. (1953) reported that the higher the candled and the broken out quality of the egg, the better was the resulting angel cake. Correlation coefficients showed that the albumen index was closely associated with angel cake quality. The albumen index also was related to volume, penetrometer measurements, and panel scores for tenderness.

St. John and Flor (1931) found that eggs that had been in storage or were a few days old gave a larger volume of foam when beaten than fresh eggs. With storage the thick white became thinner and whipped better. It was indicated that the thickness of the white rather than the age of the egg was the important factor. On the other hand, Barmore (1934) reported that eggs older than a few days did not produce as good an angel cake as fresher eggs. His idea was that there is some change besides simple liquification of the white that affects the quality of angel cakes. However, he discovered that if eggs were whipped to the same specific gravity, fresh eggs produced angel cakes identical with those prepared from eggs a few days old.

Burke and Niles (1936) conducted an experiment to determine the effect of the season on egg white performance. Two hundred and two angel cakes were baked throughout the period of study. A definite trend was found for decreased quality in the fall and winter months and a general increase during the spring and summer months. The quality of the cakes decreased in November and rose slightly in December. There was another decline in quality in

January and a sharp increase in February and March.

Sauter et al. (1954) also studied the effect of season on the quality of eggs. Their work with angel cakes compared one-day-old eggs produced during the months of January through July with eggs produced during the same months and stored from one to five weeks. Winter eggs were superior in keeping quality to summer eggs, as demonstrated by their physical quality, functional properties, and flavor. Values for the texture, volume, flavor, and grain of cakes were definitely lower for the cakes made from eggs produced during the winter. The quality of all cakes decreased significantly with storage of the eggs. Eggs in Seattle stores were sampled by Morrison (1955) during the fall, spring, and summer. Summer eggs varied more in quality than fall or spring eggs.

Treatment of Egg Whites. In a study carried out by Forsythe and Bergquist (1951) egg white was given a number of treatments to determine the effect on functional performance. Blending of the egg white was done in a Waring Blendor by means of a "flicking" technique, that is, turning the switch off and on. Egg whites were blended 25, 50, and 120 flicks. Enough time was allowed to elapse between each flick to let all motion cease within the egg white. This treatment resulted in a decrease in ovomucin fiber length accompanied by an increase in beating rate and cake volume.

Homogenization was another treatment described by Forsythe and Bergquist (1951). It was done in a Manton Ganlin, motor driven homogenizer. Pressures used were from 0 to 4,000 pounds per square inch as indicated by the pressure gauge. Homogenization

of egg whites reduced the ovomucin fiber length very little. However, the beating rate and the cake volume were greatly reduced. It also was reported by Bernard et al. (1948) that egg white homogenized at 4,000 pounds per square inch beat much more slowly than untreated egg white and produced angel cakes poor in quality.

Centrifugation was the third treatment studied by Forsythe and Bergquist (1951). Egg white was centrifuged at high speed in an air driven Sharples super centrifuge. Both a batch and continuous type bowl were used in the experiment. In the batch method the bowl was filled before centrifugation. In the continuous type bowl the egg white entered while the bowl was revolving at high speed allowing mechanical and shear forces to operate. High speed centrifugation in the batch method did not harm the egg white, although ovomucin was removed. When centrifugation was carried out in a continuous type bowl, egg quality was reduced. This was attributed to shear force. Since the removal of ovomucin resulted in no change in the beating rate in the batch type bowl, it was concluded that some entity other than ovomucin was being altered by the physical treatment.

Thermostabilization has been used to improve the keeping quality of shell eggs. The standard thermostabilization process for eggs was defined by Funk et al. (1954) as "the treatment of immersing shell eggs for 15 minutes in water held at 130° F." Both advantages and disadvantages of this process have been reported. Funk (1950) found that thermostabilization pasteurized shell eggs, devitilized fertile eggs, and stabilized the thick

egg white. However, this treatment caused the white to whip more slowly and reduced the volume of the foam. It was concluded by Cotterill and Winter (1954) that thermostabilization of eggs during agitation in water at 130° F. for 15 minutes increased the quality of the albumen, slightly increased its turbidity, and did not affect lysozyme activity.

The temperature of egg whites before beating and during storage affects their functional properties. Hunt and St. John (1931) stated that the temperature of the egg whites during beating helped determine the volume of the angel cakes made from them. The volume of cakes prepared from whites whipped at room temperature was higher than the volume of cakes made from eggs whipped at 5° C. Likewise, it was maintained by St. John and Flor (1931) that chilling eggs to ice box temperature decreased the volume of beaten egg whites, whereas heating slightly to a temperature of 18° to 20° C. before beating increased the volume.

The quality of 16,000 eggs traced from the farm through market channels by Jensen and Stadelman (1952) was decreased, regardless of market procedure, when the eggs were held without refrigeration. Refrigeration practically halted further deterioration of the eggs. Stadleman et al. (1954) also determined the quality of fresh eggs marketed with and without refrigeration. They, too, found that eggs refrigerated on the farm were of higher quality at the first receiver than those not refrigerated. However, eggs refrigerated on the farm, but not in market channels, were of no better quality in 12 days than eggs that had never been refrigerated. Stadleman and Cyrus (1952) investigated the quality

of groups of eggs stored at 45°, 50°, 55°, 60°, 65°, and 70° F. for 3, 7, 14, and 21 days, and found that as the storage time increased, colder temperatures were the most beneficial in preserving quality.

Conditions of Mixing the Cake. The conditions for mixing the cake such as the time for the addition of cream of tartar and sugar, and the altitude affect the quality of the cake. Barmore (1936) indicated that the acid should be added during the first part of the beating period in order to stabilize the foam. He found that the proper amount of acid reduced the rate of collapse of the foam two to three times from what it would have been in the absence of the acid.

Barmore (1936) baked a number of cakes to test the effect of adding various proportions of sugar to the flour on the characteristics of the cakes. The amount of sugar added to the flour varied from zero to 100 percent. The first portion of sugar was added at maximum beater speed after the eggs had been beaten to a specific gravity as near 0.160 as possible. The remaining sugar was added with the flour at minimum beater speed. Every 10 seconds one-sixteenth of the flour-sugar mixture was added and then beaten for one additional minute after all of the mixture had been added. He discovered that when most of the sugar was added to the foam before the flour, the volume of the batter and the resulting cake were better than when the sugar and flour were added together. The volume shrinkage was greatest when all of the sugar was added to the flour.

Lowe (1955), p. 349, stated that sugar increases the stability of egg white after only five to 10 seconds of beating time. Therefore, Lowe (1955), p. 362, recommended that when an electric beater is used, three-fourths of the sugar be added in the second quarter of beating. This procedure increases the whipping time and aids in preventing overbeating of the whites. In addition, she suggested that one-fourth of the sugar be sifted with the flour to help keep it from rolling into balls when folded into the egg white-sugar mixture. In her experience the combining of all of the sugar and flour before adding them to the foam has not been as satisfactory as adding all or part of the sugar to the egg white.

Altitude has a definite effect on the quality of angel cakes. Barmore (1936) reported that cakes baked at an elevation above 3,000 feet were more delicate in texture than those baked at sea level. However, the volumes of cakes baked at 10,000 feet were less than those baked at sea level, but there was more expansion during baking. Moreover, the cakes baked above sea level receded from maximum volume more readily than those with a stronger structure baked at sea level. The color of the crusts of the cakes baked at a high altitude was lighter than that of those baked at sea level.

Beating Time and Specific Gravity of the Foam. Beating time and specific gravity of the foam are related factors that affect the quality of angel cakes. Glabou (1950) tested the effect of five beating times on the quality of angel cakes. He concluded that beating time had a marked effect on the characteristics of

the finished cake. If the meringue was underbeaten or overbeaten, the finished cake suffered in volume, cell formation, and surface characteristics. It was proposed that after having established the proper beating time for the meringue for a particular type of mixer, it is important to adhere to that time. However, the character of the egg white must be considered as some eggs require a longer beating time than others.

Barmore (1936) baked a series of cakes from albumen whipped to various specific gravities. He ascertained that cakes of the greatest volume were produced from egg foam between specific gravities of 0.150 and 0.170. According to Lowe (1955), p. 360, beating the egg whites to the same specific gravity is not accepted as the best method for producing a standard product. Each type of beater has a different optimal specific gravity.

Conditions of Baking the Cake. Lowe (1955), p. 356, stated that the time of baking must be adjusted to the baking temperature, cake size, and type of pan used. She observed, p. 363, that there is no "best" temperature for baking angel cakes as high quality cakes can be baked over a wide range of temperatures. The upper limit of oven temperature would be that at which the crust is set so rapidly as to cause a reduction in cake volume. The lower limit would be that at which the cake structure sets too slowly. It was suggested that the easiest way to bake angel cakes to the same stage of doneness would be to use a thermometer or thermocouple in the center of the cake and bake to the maximum internal temperature. Regardless of the oven temperature used, the interior temperature of the cakes, for a given formula and

altitude, is nearly the same.

Miller (1942) baked angel cakes at five baking temperatures and times: 350° F. for 40 minutes; 375° F. for 35 minutes; 400° F. for 30 minutes; 425° F. for 25 minutes; and 450° F. for 21 minutes. It was observed that although the average scores of the palatability committee indicated a preference for cakes baked at 400° F. for 30 minutes and 425° F. for 25 minutes there was no great difference in the flavor and color of the cakes baked at the five temperatures. With an increase in baking temperature there was a gradual decrease in the weight of the cakes. A temperature of 425° F. for 25 minutes, higher than that usually recommended, produced the largest and most tender cake. At a temperature of 450° F. for 21 minutes the top crusts of the cakes were dark in color and tough. As the baking temperatures were decreased the crusts became lighter and more tender.

Burke and Niles (1936) reported that cakes baked at 350° F. for 45 minutes were superior in general appearance and volume to cakes baked at 325° F. for one hour. Moisture losses from cakes baked at 350° F. were always less than those baked at 325° F. However, cakes baked at 350° F. had more cracks than those baked at 325° F.

Peet and Lowe (1937) found that angel cakes baked in preheated ovens were more desirable in eating quality, texture, and tenderness and with one exception in volume, than those baked in an oven that had not been preheated.

Cost of Fresh Eggs

The Statistical Abstract of the United States (1957) quoted the average cost of market run eggs per dozen throughout the United States from the years 1930 through 1949. The lowest cost per dozen for eggs, $0.18, was listed for 1940. The cost per dozen for eggs increased every year until 1948 when it reached a high of $0.472. The price dropped to $0.452 in 1949. The World Almanac (1958) listed the price per dozen of eggs from 1950 to 1956. The average cost per dozen of eggs in the United States was $0.365 in 1950 and increased in 1951 to $0.478. In 1952 the average price dropped to $0.477, and in 1954 decreased further to $0.366, then increased to $0.387 in 1956.

The cost of large U. S. Grade A eggs from a local source near Manhattan, Kansas from July, 1957 through May, 1958 was found in a record kept in the Department of Foods and Nutrition at Kansas State College. In July, 1957 the cost per dozen was $0.39. It increased to $0.52 in September, to $0.54 and $0.55 in October; ranged from $0.54 to $0.57 in November and was $0.54 in December. In 1958 the cost per dozen dropped to $0.49 in January to $0.45 in February and ranged from $0.45 to $0.47 from March through May.

In sources such as Lowe (1955) and West and Wood (1955) it was suggested that the cost of eggs from year to year and place to place depends upon the nation's economy, fluctuations in supply and demand, and the condition and quality of the eggs produced.

PROCEDURE

Preliminary Work

Preliminary work was necessary to select the recipe and brand of mix to be used, to become acquainted with the problems involved in preparing and baking the cakes, and in performing palatability and objective tests on the cakes. A formula for angel cake was taken from Lowe's Experimental Cookery from the Chemical and Physical Standpoint (1955), p. 383, and used to standardize methods and to develop techniques for testing specific gravity of the meringue and batter, volume, palatability, tensile strength, and compressibility of the cake. Four brands of angel food cake mix were used in the same manner.

Three cakes were baked and tested at one period. Two cakes were prepared from individual ingredients and one from a mix, or one cake was prepared from individual ingredients and two from a mix. The acceptability of the cakes was determined and the preferred mix was used in the main experiment. Also, the score card to be used and the forms for recording preparation and clean-up time were tested during the preliminary work.

Main Experiment

The preparation time, quality, and cost of angel food cakes prepared from individual ingredients and a commercial mix were compared. Fifty-four cakes were baked and tested in 18 periods. At each period two cakes were prepared from individual ingredients and one from a mix, or two cakes were prepared from mixes and one

from individual ingredients. The cakes to be baked at each period, the order of mixing, and the pans and ovens to be used for each cake were selected at random. Also, the order of presenting samples of the cakes to the palatability committee were determined by randomization. The designs that were used for these procedures are given in Tables 1 and 2.

Table 1. Design used for mixing and baking the cakes.

Baking periods	Order of mixing			Oven numbers		
	1	2	3	1	2	3
1	B	A	A	B	A	A
2	A	B	B	A	B	B
3	A	A	B	A	A	B
4	B	A	B	B	B	A
5	A	B	A	A	A	B
6	B	A	A	A	B	A
7	A	A	B	A	A	B
8	A	B	B	B	A	B
9	B	B	A	A	B	B
10	B	B	A	B	A	B
11	A	B	A	A	B	A
12	B	A	B	B	A	B
13	A	B	B	A	B	B
14	B	A	B	B	B	A
15	A	A	B	A	B	A
16	B	B	A	B	B	A
17	A	A	B	A	A	B
18	A	B	A	B	A	A

A - Cakes made from individual ingredients.
B - Cakes made from a commercial mix.

Cake flour, granulated sugar, salt, cream of tartar, and pure vanilla extract sufficient for the entire experiment were purchased and stored in the laboratory where the cakes were prepared. The sugar as well as the cake flour was thoroughly mixed before the experiment was begun, and aliquots were removed as each cake

Table 2. Design used to present the angel cakes to the palatability committee.

Baking periods	Sample numbers on the score card		
	1	2	3
1	B	A	A
2	A	B	B
3	B	A	A
4	A	B	B
5	B	A	A
6	A	B	A
7	A	A	B
8	B	B	A
9	B	B	A
10	A	B	B
11	A	B	A
12	B	B	A
13	B	B	A
14	B	A	B
15	A	A	B
16	B	A	A
17	A	A	B
18	B	A	A

A - Cakes made from individual ingredients.
B - Cakes made from a commercial mix.

was prepared. Each week fresh eggs were obtained from the same source and were stored in a refrigerator. Thirty-five boxes of a commercial angel food cake mix were purchased at the beginning of the experiment, and one box selected at random each time that a cake was prepared from the mix.

The following formula (Lowe, 1955, p. 383) was used for the cakes made from individual ingredients:

Egg white	1 c.	244	gms.
Sugar	1 1/4 c.	250	gms.
Cream of tartar	1/4 tsp.	3.6	gms.
Cake flour	9/10 c.	90	gms.
Salt	1/4 tsp.		
Vanilla	1 tsp.		

The following procedure was used to mix and bake the cakes prepared from the individual ingredients:

Preheat ovens to 375° F.
Weigh flour, sugar, and cream of tartar.
Measure the salt and vanilla.
Sift 62 grams of the sugar with 90 grams of flour.
Sift 188 grams of the sugar once.

Place 244 grams of egg white into the mixer bowl (Kitchen Aid Model K-3) and bring to a temperature of 25° C. by gently rotating the bowl of egg whites in a bowl of water at 25° C.

Place egg whites in a mixing bowl, turn on the mixer and whip on speed 8 for 30 seconds (until egg whites are foamy).

Add salt, cream of tartar, and vanilla.

Whip on speed 8 for two minutes or until foam peaks bend softly. Determine by raising the beaters.

Record the whip time.

Divide the sugar into three approximately equal portions. Sprinkle the first portion of sugar over the surface of the egg white foam. Turn the mixer to speed 6 for five seconds.

Stop mixer and sprinkle the second portion of sugar over the foam. Turn mixer to speed 6 for five seconds.

Stop mixer and sprinkle the third portion of sugar over the egg white foam. Turn mixer to speed 6 for five seconds.

Stop the mixer and fill a 57 ml. cup with the meringue, weigh it, and record the weight in grams. The specific gravity of the foam was determined later by dividing the weight of the sample by an equal volume of water at the same temperature. Record the temperature of the foam.

Fold in the sugar and flour mixture in four additions. Sieve each portion over the top of the meringue and fold with a flexible spatula for 10 to 15 strokes.

Weigh 510 grams of batter into an ungreased 10-inch aluminum tube pan. Cut through the batter once to remove the air bubbles.

Bake 35 to 40 minutes at 375° F. in a household gas range.

Cool with the pan inverted.

The commercial mix contained sugar, cake flour, dried egg whites, emulsifiers, leavening, salt, and imitation flavoring. The following procedure, as given on the box of the commercial mix and modified slightly, was used to mix and bake the cakes prepared from the mix.

Preheat oven to 375° F.

Measure 1 1/3 cups water into a 4-quart mixer bowl.

Add the bag of egg white mixture and mix to moisten by turning the mixer to speed 1.

Beat to very stiff peaks at the highest speed of the mixer.

Add the flour mixture gradually over a period of 1/2 minute while the mixer is running at speed 1.

Continue to mix for 1 1/2 minutes longer; scrape the bowl as needed.

Weigh 510 grams of batter into an ungreased 10-inch aluminum tube pan. Cut through the batter once to remove air bubbles.

Bake 35 to 40 minutes.

Cool with the pan inverted.

The time spent in preparation, baking, and clean-up was recorded on Form I, Appendix. Approximately 18 hours after baking, the objective and subjective tests were performed. The volume of the cakes was determined by the seed displacement method as described by Conrad et al. (1948).

A photograph of the parts of the cake that were used for the tensile strength, compressibility, and palatability tests is included (Plate I). To obtain comparable results when testing the baked cakes, it was necessary that all samples be uniform in width. Therefore, a three-sided metal gauge was used to measure the slices. The dimensions of the gauge were 3 3/4 inches by 4 inches with projecting sides one inch in width. One cut was made in the cake, the gauge slipped over the cake and a one-inch slice was cut. The knife was dipped in warm water and wiped on a damp cloth. Four slices were used for palatability tests and four for the compressibility test. Four one-inch cores were cut from the cake by means of a sharp cylinder and were used to test the tensile strength of the cakes (Plate II). All samples were wrapped in aluminum foil to prevent drying.

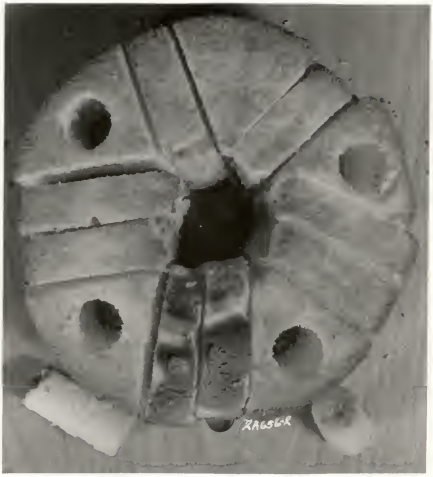
The tests for compressibility and tensile strength were done according to the procedures described by Conrad et al. (1948). A palatability committee of seven women scored the samples for texture, tenderness, and flavor using Form II (Appendix). A record of the cost of the cakes made from the individual ingredients and cakes made from the mix was kept and compared.

All data were tabulated, averaged, and analyzed by Students' t-test.

EXPLANATION OF PLATE I

This plate shows the design used for sampling the cakes. The small, round holes represent the position of the four cores used for the tensile strength test. The upper and lower slices were used for the compressibility test and the slices to the right and left of the center of the cake were used for the palatability samples.

PLATE I



EXPLANATION OF PLATE II

The two cores removed from the cake and shown at the right and left of the plate show the size and uniformity of the samples used for tensile strength determinations.

PLATE II

RESULTS AND DISCUSSION

Mixing, Baking, and Cleanup Time

The average data for mixing, baking, and cleanup time are presented in Table 3. The cakes made from individual ingredients required on the average 26.6 minutes more total preparation time than cakes prepared from a commercial mix. The average time spent in mixing cakes from individual ingredients was 24 minutes longer than that used to mix the cakes from the commercial mix. The average baking times were about the same, 34 minutes for cakes prepared from individual ingredients and 33 minutes for the cakes prepared from the mix. Three minutes longer, on the average, were required for cleanup time for cakes prepared from individual ingredients than for cakes prepared from a commercial mix. There were no significant differences between the cleanup times and the baking times for the two methods. However, Student's t-test indicated that the mixing time, and therefore the total preparation time, was significantly ($P < .001$) longer for the cakes prepared from individual ingredients than for the cakes prepared from the commercial mixes.

There was some variation in the time required to mix both types of cakes, but the variation was less for the cakes prepared from the mix than for those made from individual ingredients. The time required for the cakes prepared from individual ingredients ranged from 25 to 60 minutes, and for those made from the commercial mix from 10 to 30 minutes (Table 6, Appendix). The mixing time did not decrease steadily as the work progressed.

Table 3. Average data relative to preparation time, objective, and subjective tests for angel cakes made from individual ingredients and a commercial mix.

Factors	Cakes: Individual ingredients		Cakes: Mix
Preparation time, min.			
Mixing	39.3	***	15.0
Baking	34.1	ns	33.0
Cleanup	15.9	ns	12.0
Total	89.2	***	62.6
Specific gravity, meringue	0.21	*	0.20
Specific gravity, batter	0.31	ns	0.31
Volume, ml./gm. batter	4.9	ns	5.0
Flavor scores[1]	4.2	ns	4.4
Texture scores[1]	3.4	***	4.4
Compressibility, cm.	3.1	ns	3.1
Tenderness scores[1]	3.7	***	4.4
Tensile strength, gms.	51.2	*	48.6

[1] Range, 1 to 5; maximum, 5.
* Significant at the 5% level.
*** Significant at the 0.1% level.

Instead, variation in mixing time occurred from day to day throughout the experiment.

Quality of the Products

Specific Gravity of the Meringue and Batter and the Volume of the Cake. Lowe (1955), p. 360 pointed out that it would seem

that the simplest way to duplicate the results in an experiment would be to control the specific gravity of the foam and batter. She continued that this is true to a certain extent, because there is a close correlation between the specific gravities of the foam and batter and the volume of the cake. However, each type of beater has an optimum specific gravity. For example, a specific gravity of 0.09 to 0.11 may give the maximum cake volume for a fine-wired whip, whereas 0.15 to 0.17 may produce the best results with a hand operated rotary beater. Barmore (1936) found that maximum cake volume was produced when the specific gravity of the meringue was between 0.15 and 0.17. Above 0.17 there was not enough air occluded in the foam to produce the lightest cake, and below 0.15 the stability of the foam was sufficiently reduced by the extra beating so that the finished cake was smaller.

In the study reported here, there was not a significant correlation between the specific gravity of the meringue or batter and the volume of the cakes prepared from individual ingredients or a mix. The correlation coefficients for these factors all were low (Table 4). Student's t-test indicated that the average specific gravity of the meringue was significantly higher ($P < .05$) for the cakes prepared from individual ingredients than for the cakes prepared from the commercial mix (Table 3). However, from a practical standpoint the difference in the average specific gravity of the meringues for the cakes prepared by the two methods was not an important one. The average specific gravity for the batters was the same for both treatments (Table 3). The specific gravity for the meringue ranged from 0.18 to 0.26

Table 4. Correlation coefficients for the specific gravity of the meringue and batter vs. the volume of the cakes.

Factor	Individual ingredients	Commercial mix
	r	r
Specific gravity, meringue vs. volume	0.198 ns	0.374 ns
Specific gravity, batter vs. volume	0.155 ns	0.213 ns

for the individual ingredients and from 0.18 to 0.23 for the mixes (Table 7, Appendix). This might be explained by the fact that the meringues were whipped for a definite length of time rather than to a definite specific gravity. The specific gravities for the batters varied from 0.28 to 0.34 for the individual ingredients and from 0.27 to 0.36 for the mixes.

The average volume of the cakes prepared from individual ingredients was about the same as that for the cakes prepared from the commercial mix (Table 3). The volume of the cakes also varied from day to day. The volume ranged from 4.4 ml. per gram of batter to 5.3 ml. per gram of batter for the cakes prepared from individual ingredients, and from 4.5 ml. per gram of batter to 5.3 ml. per gram of batter for the cakes prepared from mixes.

Palatability. The average of mean palatability scores are presented in Table 3, and the detailed data are given in Table 8 in the Appendix. In general, the mean scores for the palatability factors were slightly higher for the cakes made from the commercial mix than for those made from individual ingredients.

The difference between the flavor scores for the cakes prepared by the two methods was not significant. The flavor scores

ranged from 2.3 to 5.0 for cakes prepared from individual ingredients and from 4.0 to 5.0 for the cakes prepared from the commercial mix. The cakes prepared from the commercial mix were judged significantly ($P < .001$) better in texture than the cakes prepared from individual ingredients (Table 3). The cakes prepared from the mix had a finer grain, more even texture, and thinner cell walls than those prepared from individual ingredients. Plate III is a photograph in which some of these differences may be observed. The texture scores ranged from 2.3 to 4.7 for the cakes prepared from individual ingredients and from 3.2 to 5.0 for the cakes prepared from the commercial mix.

Compressibility of the crumb has been considered an important factor in the freshness of bread (Platt and Powers, 1940). Also the compressibility test has been used to show variation in texture from slice to slice or to expose the presence of lumps in bread. In the study reported here, there was no difference between the mean compressibility readings of the cakes prepared from individual ingredients and the commercial mix. However, the palatability committee scored the cakes prepared from the commercial mix significantly ($P < .001$) more desirable in texture than the cakes prepared from individual ingredients. The detailed data in Table 9 (Appendix) show that there was quite a bit of variation from day to day in the compressibility readings, especially for the cakes prepared from the commercial mix. The mean compressibility values for the cakes prepared from individual ingredients ranged from 2.3 cm. to 4.0 cm., whereas those for the cakes prepared from the commercial mix ranged from 1.4 cm. to

EXPLANATION OF PLATE III

This photograph shows the characteristic texture of the angel cakes prepared from individual ingredients and a commercial mix. The upper slice was taken from a cake prepared from individual ingredients and the lower slice was taken from a cake prepared from a commercial mix.

PLATE III

4.9 cm.

The cakes prepared from the commercial mix were scored significantly ($P < .001$) more tender than the cakes prepared from individual ingredients. Panel members commented several times that cakes prepared from the commercial mix "melted in the mouth." The apparatus used to measure tensile strength measured the force required to pull apart a one-inch core of the cake. The mean values for tensile strength were significantly ($P < .05$) lower for the cakes prepared from the commercial mix than for the cakes prepared from the individual ingredients (Table 3). These results are consistent with the palatability scores for tenderness, and indicate that the cakes made from the commercial mix were more tender than those prepared from individual ingredients. Detailed data are recorded in Table 8 (Appendix). The tensile strength values varied from 42.8 grams to 64.3 grams for the cakes prepared from individual ingredients and from 42.3 grams to 57.1 grams for the cakes prepared from the commercial mixes.

Cost

Angel food cakes prepared from individual ingredients and those prepared from the commercial mix both cost $0.37 per cake (Table 5). The cost of the egg whites for cakes prepared from individual ingredients was figured as 62.5 percent of the cost of whole eggs. It was assumed that each egg white weighed 30 grams and each yolk 18 grams. Eggs were the main item of expense for the cakes prepared from individual ingredients. Therefore, the cost of angel cakes prepared from individual ingredients will vary

Table 5. Cost of angel cakes prepared from individual ingredients and a commercial mix.

Factor	Total cost	Unit cost	Cost per cake
Individual ingredients			
Cake flour	$1.12	$0.0825/lb.	$0.041
Sugar	1.62	0.10/lb.	0.06
Egg whites[1]	5.89	0.2875/doz.	0.218
Cream of tartar	0.25	0.25/box	0.009
Vanilla	1.08	0.47/bottle	0.04
Total	9.96		0.368
Commercial mix	$9.99	$0.37/box	$0.370

[1] The cost of egg whites was figured as 62.5 percent of the cost of whole eggs.

from time to time and place to place as the price of eggs may vary. This experiment was conducted from March through May, 1958.

Asp et al. (1957) reported that the commercial mixes for chocolate chip cookies, pie crust, yellow cake, and baking powder biscuits were more expensive than the cost of the products prepared from individual ingredients or a homemade mix.

SUMMARY

The purpose of this study was to compare the quality and the cost, in time and money, of angel food cakes prepared from individual ingredients and a commercial mix.

Fifty-four cakes were baked and tested in 18 periods. At each period two cakes were prepared from individual ingredients and one from a mix, or two cakes were prepared from a mix and one from individual ingredients. The cakes to be baked at each period, the order of mixing, and the pans and ovens to be used for each cake were selected at random. Also, the order of presenting samples of the cakes to the palatability committee was determined by randomization. A record was kept of the cost of the cakes and the time spent in preparation, baking, and cleanup. Other data collected were values for the specific gravity of the meringue and batter, the volume, compressibility, tensile strength, and palatability of the cakes. All data were tabulated, averaged, and analyzed by Student's t-test.

The mixing time, and therefore the total preparation time, was significantly ($P < .001$) longer for the cakes prepared from individual ingredients than for the cakes prepared from the commercial mix. There was no significant difference between the two methods for the cleanup and baking time.

Student's t-test indicated that the average specific gravity for the meringue was significantly ($P < .05$) higher for the cakes prepared from individual ingredients than for the cakes prepared from the commercial mix, but the difference was not of practical importance. The average specific gravity for the batters was the same for both treatments. The average volume of the cakes prepared from individual ingredients was about the same as the average volume of the cakes prepared from the commercial mix.

The difference in the flavor scores for the cakes prepared by the two methods was negligible. The cakes prepared from the commercial mix were judged significantly ($P < .001$) better in texture than the cakes prepared from individual ingredients. There was no difference between the mean compressibility readings for the cakes prepared from individual ingredients and a commercial mix.

The mean values for tensile strength were significantly ($P < .05$) lower for the cakes prepared from the commercial mix than for the cakes prepared from individual ingredients. These results are consistent with the palatability scores for tenderness, and indicate that the cakes made from the commercial mix were more tender than those prepared from individual ingredients.

Angel cakes prepared from individual ingredients and those prepared from the commercial mix both cost $0.37 per cake.

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APPENDIX

Form I

Time Spent in Preparation, Baking, and Cleanup

Date_____

	Sample____	Sample____	Sample____
Preparation:			
Begin work	_____	_____	_____
Possible Interruption:			
Started	_____	_____	_____
Ended	_____	_____	_____
End Preparation	_____	_____	_____
Total Prep. Time	_____	_____	_____
Baking:			
End Preparation	_____	_____	_____
Put cake in oven	_____	_____	_____
Take cake from oven	_____	_____	_____
Total Baking Time	_____	_____	_____
Clean Up:			
Put away excess food and containers			
Clean preparation area			
Wash and put away utensils			
Started	_____	_____	_____
Ended	_____	_____	_____
Total cleanup time	_____	_____	_____

Form II

Score Card for Angel Food Cake

Name_____ Date_____

Sample Number	Texture	Tenderness	Flavor
1	_____	_____	_____
2	_____	_____	_____
3	_____	_____	_____

Rating Points:

5 - Excellent

4 - Good

3 - Fair

2 - Poor

1 - Unacceptable

Place the rating point for the factor being scored in the space adjacent to each sample number. An excellent product should have a pleasing, not too acid flavor, a fine texture with even size cells and thin cell walls, and should be tender enough to disintegrate easily in the mouth.

COMMENTS:

Table 6. Data related to the mixing, baking, and cleanup time used to prepare angel cakes from individual ingredients and a commercial mix.

Replications	Time record, min.							
	Individual ingredients				Mix			
	Mixing	Baking	Cleanup	Total	Mixing	Baking	Cleanup	Total
1	55	35	10	100	30	30	10	70
2	30	35	10	75	10	35	5	50
3	30	35	15	80	17	35	13	65
4	30	35	10	75	20	35	10	65
5	35	35	5	75	15	35	5	55
6	40	35	15	90	15	30	15	60
7	45	35	15	95	15	30	10	55
8	35	35	10	80	30	35	30	95
9	60	35	15	110	10	35	10	55
10	30	35	45	110	15	35	30	80
11	30	35	15	80	15	40	10	65
12	45	35	20	100	15	35	15	65
13	60	35	20	115	15	35	10	60
14	30	25	20	75	15	30	15	60
15	45	30	20	95	18	30	7	55
16	35	35	20	90	15	35	10	60
17	50	35	15	100	15	35	10	60
18	40	35	15	90	10	30	15	55
19	35	35	20	90	15	35	10	60
20	40	35	15	90	20	35	10	65
21	45	30	15	90	15	30	15	60
22	60	35	15	110	15	30	20	65

Table 6 (concl.).

Replications	Time record, min.							
	Individual ingredients				Mix			
	Mixing	Baking	Cleanup	Total	Mixing	Baking	Cleanup	Total
23	40	35	20	95	15	35	15	65
24	30	35	10	75	10	35	10	55
25	25	30	10	65	15	35	15	65
26	35	35	15	85	15	35	15	65
27	25	35	15	75	15	35	10	60
Av.	39.3	34.1	15.9	89.2	15	33	12	62.6

Table 7. Data related to the batter and volume of angel cakes prepared from individual ingredients and a commercial mix.

Replications	Specific gravity				Volume	
	Meringue		Batter		ml./gm. of batter	
	Individual ingredients	Mix	Individual ingredients	Mix	Individual ingredients	Mix
1	0.22	0.19	0.29	0.36	4.4	4.5
2	0.22	0.18	0.32	0.30	4.5	4.6
3	0.20	0.18	0.29	0.27	4.7	4.7
4	0.19	0.18	0.28	0.27	4.6	4.7
5	0.19	0.19	0.29	0.27	4.6	5.2
6	0.19	0.19	0.30	0.30	4.6	4.8
7	0.22	0.21	0.29	0.29	5.0	4.7
8	0.18	0.22	0.29	0.30	4.9	4.7
9	0.19	0.19	0.30	0.29	5.2	5.0
10	0.19	0.22	0.30	0.32	5.2	5.1
11	0.22	0.22	0.29	0.32	5.2	5.2
12	0.22	0.22	0.29	0.32	5.2	5.1
13	0.23	0.22	0.32	0.32	4.9	5.0
14	0.22	0.23	0.32	0.31	4.8	5.1
15	0.20	0.21	0.29	0.31	4.9	5.0
16	0.23	0.22	0.34	0.34	4.9	5.1
17	0.22	0.19	0.32	0.31	4.8	5.2
18	0.22	0.22	0.32	0.31	5.1	5.1
19	0.26	0.23	0.34	0.36	5.3	5.2
20	0.21	0.23	0.30	0.30	5.1	5.1
21	0.22	0.21	0.34	0.34	4.9	5.3
22	0.22	0.20	0.31	0.32	5.0	5.1

Table 7 (concl.).

Replications	Specific gravity: Meringue: Individual ingredients	Specific gravity: Meringue: Mix	Specific gravity: Batter: Individual ingredients	Specific gravity: Batter: Mix	Volume: ml./gm. of batter: Individual ingredients	Volume: ml./gm. of batter: Mix
23	0.21	0.20	0.32	0.29	5.0	5.2
24	0.22	0.20	0.30	0.31	4.6	4.9
25	0.21	0.19	0.31	0.32	4.7	5.3
26	0.20	0.19	0.30	0.29	5.1	5.3
27	0.21	0.19	0.30	0.29	5.2	4.7
Av.	0.21	0.20	0.31	0.31	4.9	5.0

Table 8. Mean palatability scores for angel cakes prepared from individual ingredients and a commercial mix.

Replications	Palatability factors: Flavor: Individual ingredients	Flavor: Mix	Texture: Individual ingredients	Texture: Mix	Tenderness: Individual ingredients	Tenderness: Mix
1	4.6	4.2	3.6	4.6	4.2	4.2
2	4.6	4.6	3.6	4.8	3.6	4.8
3	4.4	4.8	3.8	5.0	4.0	5.0
4	4.5	4.3	4.0	4.5	4.2	4.8
5	4.2	4.3	3.8	4.5	3.8	4.2
6	4.3	4.5	3.3	4.0	3.5	4.0
7	4.5	4.5	3.5	4.5	3.7	4.0
8	4.3	4.0	3.7	3.8	3.8	4.0
9	4.2	4.2	3.4	4.4	3.8	4.6
10	4.0	4.8	3.4	4.5	3.6	4.8
11	4.4	4.8	4.0	4.0	3.8	4.8
12	4.4	4.5	3.7	4.5	3.6	4.2
13	4.3	4.2	3.5	4.0	3.7	4.8
14	4.0	4.6	3.5	4.6	3.3	4.2
15	4.4	4.0	3.6	4.8	4.0	4.4
16	3.8	4.4	2.8	4.4	3.2	4.4
17	4.0	4.7	2.8	4.3	2.8	4.7
18	4.2	4.2	4.7	3.2	4.2	3.8
19	4.2	4.5	3.0	4.5	3.7	4.5
20	4.0	4.3	3.2	4.0	4.0	4.3
21	4.7	4.2	3.2	4.3	3.7	4.0
22	4.2	4.5	3.0	5.0	3.3	4.5

Table 8 (concl.).

Replications	Palatability factors					
	Flavor		Texture		Tenderness	
	Individual ingredients	Mix	Individual ingredients	Mix	Individual ingredients	Mix
23	4.4	4.5	3.0	4.2	3.6	4.6
24	2.3	4.4	2.3	4.0	2.0	4.2
25	3.0	4.2	2.5	4.4	2.5	4.7
26	5.0	4.0	3.0	4.0	5.0	5.1
27	5.0	5.0	4.0	5.0	5.0	5.2
Av.	4.2	4.4	3.4	4.4	3.7	4.4

Table 9. Mean tensile strength and compressibility values for angel cakes prepared from individual ingredients and a commercial mix.

Replications	Tensile strength, gms.		Compressibility, mm.	
	Individual ingredients	Mix	Individual ingredients	Mix
1	49.4	57.1	3.0	3.3
2	52.2	53.4	3.9	3.6
3	52.0	54.4	3.1	3.5
4	51.6	52.0	4.0	3.8
5	53.8	56.3	3.6	4.9
6	64.3	48.2	3.1	2.7
7	54.5	52.9	3.0	2.2
8	58.5	56.7	3.3	2.8
9	51.8	49.2	2.9	3.1
10	51.1	45.6	3.1	2.7
11	50.4	43.2	2.8	1.4
12	50.7	46.5	2.7	2.8
13	53.7	45.4	3.7	2.9
14	51.3	45.7	3.6	2.7
15	45.8	52.1	3.0	2.5
16	52.0	47.3	2.3	2.9
17	48.6	43.4	2.7	3.4
18	44.8	42.3	3.1	3.8
19	45.5	45.7	3.2	3.7
20	55.4	46.4	3.1	3.9
21	48.0	48.3	3.3	2.4
22	46.4	49.0	3.4	3.0

Table 9 (concl.).

Replications	Tensile strength, gms.		Compressibility, mm.	
	Individual ingredients	Mix	Individual ingredients	Mix
23	46.4	46.6	2.7	3.4
24	53.1	45.4	3.0	3.5
25	59.0	45.8	2.9	3.4
26	46.0	46.0	2.8	3.1
27	45.9	46.0	2.6	2.9
Av.	51.2	48.6	3.1	3.1

THE QUALITY AND COST IN TIME AND MONEY OF ANGEL FOOD CAKES PREPARED USING INDIVIDUAL INGREDIENTS AND A COMMERCIAL MIX

by

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The use of commercial mixes has increased greatly in the last five years, and today practically any baked product can be purchased in mix form. Generally, mixes are used to save time. It is important for modern homemakers to consider the amount of money and time they spend in food preparation in relation to the quality of the food which they produce. Some research has been done comparing several baked products made from mixes with products made from individual ingredients. In these studies the cost, in time and money, and the acceptability of the products were determined. No study of this type was found in the literature concerning angel food cakes. Therefore, it was deemed worthwhile to conduct a study to compare the quality and cost, in time and money, of angel food cakes prepared from individual ingredients and a commercial mix.

Fifty-four cakes were baked and tested in 18 periods. At each period two cakes were prepared from individual ingredients and one from a mix, or two cakes were prepared from a mix and one from individual ingredients. The cakes to be baked at each period, the order of mixing, and the pans and ovens to be used for each cake were selected at random. Also, the order of presenting samples of the cakes to the palatability committee was determined by randomization. A record was kept of the cost of the cakes, and the time spent in preparation, baking, and cleanup. Other data collected were values for the specific gravity of the meringue and batter, the volume, compressibility, tensile strength, and palatability of the cakes. All data were tabulated, averaged, and analyzed by Student's t-test.

The mixing time, and therefore the total preparation time, was significantly ($P < .001$) longer for the cakes prepared from individual ingredients than for the cakes prepared from the commercial mix. There was no significant difference between the two methods for the cleanup and baking time.

Student's t-test indicated that the average specific gravity for the meringue was significantly ($P < .05$) higher for the cakes prepared from individual ingredients than for the cakes prepared from the commercial mix, but the difference was not of practical importance. The average specific gravity for the batters was the same for both treatments. The average volume of the cakes prepared from individual ingredients was about the same as the average volume of the cakes prepared from the commercial mix.

The difference in the flavor scores for the cakes prepared by the two methods was negligible. The cakes prepared from the commercial mix were judged significantly ($P < .001$) better in texture than the cakes prepared from individual ingredients. There was no difference between the mean compressibility readings for the cakes prepared from individual ingredients and a commercial mix.

The mean values for tensile strength were significantly ($P < .05$) lower for the cakes prepared from the commercial mix than for the cakes prepared from individual ingredients. These results are consistent with the palatability scores for tenderness, and indicate that the cakes made from the commercial mix were more tender than those prepared from individual ingredients.

Angel cakes prepared from individual ingredients and those prepared from the commercial mix both cost $0.37 per cake.