DEVELOPING GUIDELINES FOR QUANTIFYING A PLAIN CAKE RECIPE

by 6408

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INTRODUCTION

The production of high quality food is an important concern of food service operators. Standardization programs for both the production of quality food and profit control are important to persons responsible for the direction of food service activities.

Many institutional recipes have not been standardized for quantity food production. Principles and guidelines are not available to insure desirable results when recipes are quantified. Cranmore (1954a) noted the lack of basic information on the rules for developing and balancing quantity food formulas.

A survey of 25 food service directors each preparing food for more than 1,000 persons for each of the three meals per day indicated the intense need and a strong interest for basic information on recipe quantification (Prideaux, 1965). In large food production centers, recipe expansion usually is done by the trial and error method, which is not practical in terms of cost of ingredients and work time.

Miller (1968) reported no appreciable difference in the characteristics of the batter and cake quality when a standardized 50-serving plain cake formula was quantified four times to provide 200 servings. With the trend toward larger and larger food service units, principles of quantification are needed for large units up to 500 or even 1,000 servings.

Based on the need for basic information, a project was undertaken to establish guidelines for quantifying food formulas. The purpose was to determine the effect of quanitfying a standardized 50-serving plain cake formula to 400 and 500 servings on selected characteristics of the batter and the baked cake. On the basis of the results certain guidelines for quantifying a plain cake recipe are to be established.

REVIEW OF LITERATURE

Recipe Standardization

The recipe is one of the basic tools in the production of quality food. Janssen (1958) stated that the recipe is a practical tool, but it can and should represent the application of research findings and experimentation.

Standardized recipes are good, dependable control tools. Aldrich and Miller (1963) defined a standardized recipe as "a recipe which has been tested, under carefully controlled conditions for yield and quality for a specific situation." Graham (1953) pointed out that standardized recipes establish procedures that will make possible the production of consistently high quality food.

Mitchell (1949) recommended that every food service operation should have a standardized recipe file. According to her, this is not difficult to establish but does require work, extra time and patience.

There is no one plan available to insure recipe standardization for every food service operation. However, there are some fundamental considerations that can serve as general guides.

A personal appreciation for high quality products by the food administrator or dietitian has been considered a primary step in the establishment of a recipe standardization program (Anonymous, 1964). Miller and Goodenow (1962) stressed that the food administrator should recognize the need for a standardization program.

Recipe standardization is not a one man proposition. To be successful, Miller and Goodenow (1962) emphasized that the supervisors and employees also should recognize the need for the program and should be included in planning the program. The standardization program involves the coordination of the goals and efforts of everyone in the department. The interest, participation and cooperation of the employees can be the keynote to success in the recipe testing program (Cranmore, 1954a).

The next step involves an operational survey and analysis. Cranmore (1953b) stated that by reviewing the present recipe system, one discovers its weaknesses and the need for improvement. Analysis of the present set-up should include notation of the types of patrons to be served, menu acceptability, the food preparation equipment available and needed, securing cooperation and assistance of employees, and compiling the list of recipes to be standardized.

After the operational survey, the aims of recipe standardization should be established and the program formulated on paper. The work plan should include the recipes to be standardized and a schedule for standardization. Miller and Goodenow (1962) suggested that a procedure for developing and testing the selected recipes be formulated. In addition, Aldrich and Miller (1963) suggested development of a check sheet or card for recording information about the finished product.

As part of the program, Cranmore (1953a) proposed that a regular routine check-up of the performance of scales and thermostatically controlled precision equipment be established. Accurate measurements mean a great deal in successful quantity food production.

Working out the standardization plan is usually the major difficulty. Cranmore (1953a) stated that initiating the idea is 5% of the work and 95% is follow through. It also was suggested that one key person be designated to execute and supervise the plan.

Cranmore (1954b) recommended a conference with the production employees one day before the actual preparation. The purpose of the conference is an open discussion for a better understanding of the plan by the employees. On the day of the actual preparation, the management person designated to execute the plan should spend as much time as possible with the employees and personally observe that each step is interpreted correctly and prepared accurately. The finished product, the records of the preparation, and actual serving yield of the product should be examined. Atkinson (1962) advocated the use of a work-sheet to record such details as the results obtained, the progress of the work, and suggestions for improvements in the next testing.

If necessary, the recipe should be rewritten with the production employees (Cranmore, 1954b). This will improve and simplify techniques for the next trial, which should occur as soon as it is included in the menu again. The testing period can be a good time to try out new simplified food preparation methods and offers opportunity to experiment with new food items. The yield may be adjusted, if necessary.

Aldrich and Miller (1963) recommended that repeated trials on each product be done until at least three successful runs have produced the quality and the exact amount desired. Cranmore (1954b) stated that only by careful and repeated testings can a standardized recipe be developed and perfected.

It was suggested by Aldrich and Miller (1963) and Cranmore (1954b) that as a final check, a "new person" prepare the recipe from the written worksheet without assistance. This can be revealing for it may show the need for more detailed and/or simplified information on the final recipe.

The last step is to set-up the recipe in a finished form for the permanent file. For long range programs, Aldrich and Miller (1963) suggested that progress and problems of standardization should be discussed frequently with the supervisors and employees. Management should develop in the personnel a sense of accomplishment, responsibility, and personal pride as each recipe is completed and as the program progresses towards its goal.

The completion of a standard recipe is not the end of the program. According to Miller and Goodenow (1962) recipe standardization is never finished because recipes must be revised as people, equipment, costs, menus, and food products change.

In conjunction with the recipe standardization program, Williams (1946) suggested the establishment of a Standardization and Testing Department or a Test Kitchen. Cranmore (1963) implied that a test kitchen is a means to an end; not an end in itself. It is a means of attaining high quality food and establishing standard portions and costs as well as teaching employees. It is a method of combining the art and the science of cooking for quality food production.

Recipe Expansion

Procedure for Quantifying Small Recipes

When converting a family size recipe to large quantity, Aldrich (1953) stressed the importance of knowing ingredients, exact amounts, and mixing procedures. She also pointed out that the time and temperature of cooking and baking given for the family-size recipe should be used as guides for quantity production of high quality foods. The development of the large quantity recipe should be done step-by-step. First, the small-size recipe should be prepared, proceeding carefully and exactly according to directions. The original recipe is worked on until the quality of the product desired is obtained and two or three trials run to be sure that the recipe can be reproduced. When a stage yields a satisfactory product, the procedure should be repeated doubling the quantity. Careful observation of the mixing and evaluation of the product should be done at every stage. If the product quality at a certain yield is not the same as the family-size recipe, the recipe should be rechecked. Keeping notes and accurate records of the changes are important for the next step. Aldrich and Miller (1963) recommended that after the recipe has been increased to yield 100 servings or close to 100, adjustment for handling and/or cooking loss should be made. An allowance of 3 to 5% of the total batter was recommended for handling and/or cooking loss. Cranmore (1954a) suggested the same procedure in developing a quantity recipe from the family-size recipe and stressed the importance of using high quality ingredients.

MacFarlane (1959) gave a procedure for quantifying bakery products from a family-size recipe. The original recipe is prepared several times incorporating changes, if necessary, until the product obtained is of the quality desired. It is at this point that expansion begins. The quantifying procedure follows:

1. The supervisor discusses the recipe and product with the production employee one day before the actual testing. If unusual ingredients, methods, or equipment are involved a demonstration is given by the supervisor.

2. The supervisor decides the quantity to be made.

3. On the day of preparation, the supervisor observes the step-to-step procedure and instructs the worker, if needed.

4. The supervisor keeps a careful and accurate record of the speed, mixing time, temperature of baking, and other essential factors.

5. The product is evaluated and compared with a standard product made from the original recipe.

6. At every stage of quantification after a satisfactory product is

obtained, a different or new worker is asked to prepare the recipe without assistance. The result is evaluated and compared with the standard product.

7. If the product is satisfactory it is suggested that the recipe be expanded step-by-step to a maximum amount of 15 times the original recipe. If the recipe is acceptable, it becomes a part of the permanent file.

Quantifying and standardizing recipes may seem to be tedious and time-consuming tasks, but rewards are considerable. As Aldrich (1953) indicated, with careful, methodical, step-wise procedure it is possible to develop quantity recipes from many good family-size recipes.

Methods of Adjusting the Recipe Yield

Adjusting the recipe yield is a time consuming task. Callahan (1965) indicated that yield adjustment needs some mathematics which may be beyond the abilities of many cooks and bakers. Because of the mathematics involved in changing recipe yields, errors can occur easily with resulting wastes or poor products. In adjusting a recipe yield the ingredient weight or measure may be used as a basis. For quantity food preparation, the use of weights has been found to be more accurate and practical than the use of measures (Jackson, 1931; Monroe, 1931; Newbill, 1931; Welsh, 1931).

Several methods are used for adjusting recipe yield. The ones commonly used are the factor method and the percentage method. Other methods are the direct reading of tables and a "slide rule" device.

In the factor method, a basic factor is obtained by dividing the desired yield by the known yield of the recipe. The amount of each ingredient is multiplied by the factor in order to obtain the desired yield. When using this method, Callahan and Aldrich (1959) suggested converting measures in the original recipe to weights. The factor method requires careful calculations especially in the conversion of fractions or decimals. Aldrich and Miller (1963) commented that this method is time consuming and needs much concentration.

With the percentage method, the weights of all the ingredients are added to determine the total weight or 100 per cent, and the percentage of each ingredient is calculated. The percentage for each ingredient is obtained by dividing the weight of each ingredient by the total weight of all ingredients in the recipe. According to Callahan and Aldrich (1959) the advantage of this method is that the percentage can be used for any desired yield.

For minimum calculation, Aldrich and Miller (1963) recommended the use of a direct reading weight table for adjusting recipe yields. However, its use is limited to adjusting a recipe of known yield to one of the amounts indicated at the top of the columns to desired yields divisible by 25.

With the "slide rule" device, each ingredient is listed in terms of percentage of the total weight of the recipe. With the known percentage, the recipe yield can be adjusted precisely to any desired yield by using a conversion chart with a slide rule-type bar. The conversion charts are given in terms of pounds and ounces and conversion is, therefore, limited to recipes whose amounts are given originally in pounds and ounces. This method simplifies yield adjustment and is time-saving, practical, and accurate (Callahan, 1965).

In addition to the conversion chart a second tool is used to adjust recipe yield. This is the "Yield Control Guide", which gives the expansion factor of recipes and provides for normal cooking and handling losses. The conversion chart determines at what point the slide rule bar should be set to adjust the yield of a particular recipe (Callahan 1960; 1965).

Cake Formulas

Ingredients, Functions and Their Effect on Quality

The basic ingredients for shortened cakes are flour, sugar, shortening, egg, liquid, and a chemical leavening agent (Lowe, 1955; Peckham, 1969; Pyler, 1952; Sweetman, 1954; Vail, 1967). Generally, cake flour is preferred for making cakes. Peckham (1969) stated that the best grade cake flour usually has a low protein content of 7.0 to 8.5 per cent which forms a soft yielding gluten that does not grow tough when it is mixed. It was reported by Pyler (1952) that flour with a fine and uniform granulation produced a high quality cake because fine granulation facilitates the dispersion of the flour in the cake batter.

It is commonly known that the flour is responsible for the framework or structure of baked products. Vail et al (1967) described the effect of flour on the consistency of flour mixtures in proportion to the liquid. Too little flour results in a thin mixture with a product that spreads too much, tends to fall and is soft, moist, and sometimes soggy. On the other hand, too much flour results in a product that has a dry, harsh texture and uneven shape due to failure to spread and difficulty in handling.

The flour framework is modified by the other ingredients. Several authors (Lowe, 1955; Pyler, 1952; Sweetman, 1954) stated that sugar has a tenderizing effect on the gluten and egg proteins of the batter and thus contribute to certain texture effects such as tenderness, closeness of grain or crispness depending on the ingredients. This tenderizing effect is brought about because sugar retards the coagulation by its peptizing effect on proteins.

Sugar adds flavor by contributing sweetness to the baked product. It also gives a brown color during baking and, therefore, enhances the browning of the crust as the sugar of the mixture caramelizes during baking (Fitch, 1948).

Increasing the amount of sugar up to optimum level tended to increase the volume and tenderness of the baked product as shown by Lowe (1955). However, a batter with too much sugar produced a cake of smaller volume, with coarse, large cells, sugary crust and crumbly.

One important function of shortening in cake making is imparting tenderness or shortness to the cake crumb. It is one of the major factors in producing a soft, velvety crumb. This tenderizing effect is brought about by the capacity of the fat to coat flour particles thus forming a film of fat which prevents a continuous gluten formation (Sweetman, 1954; Fitch, 1948).

Pyler (1952) stated that another function of shortening is the emulsification and holding of considerable amounts of liquid. This adds mechanical strength to the batter and reduces the tendency of the batter to fall on its own weight before the heat coagulates the gluten and egg structure and gelatinizes the starch.

The type of fat was found to affect the shortening power. As shown by the work of Jooste and Mackey (1952), cakes made with superglycerinated shortening have a larger volume than those prepared with nonglycerinated shortening. The glycerides act as emulsifiers which facilitate good distribution of fat in the batter and thus aid in the dispersion of air bubbles in the batter (Vail et al, 1967). Shortening also aids in leavening the product. Peckham (1969), Lowe (1955), and Sweetman (1954) explained that during the creaming process the shortening entraps air, thereby contributing to the leavening of the batter and resulting in an increase volume of the baked product.

Eggs perform several important functions in the cake batter. Several authors stated that the proteins in eggs which are extendable and coagulated during baking, form a portion of the cake framework (Pyler, 1952; Peckham, 1969; Sweetman, 1954). Pyler (1952) asserted that the principle function of egg is more of stabilization than structure formation and explained that the protein film that is distributed throughout the batter helps in the retention of gas generated by the baking powder and also contributes to the uniformity of cell structure by preventing the formation of large air cells.

Peckham (1969) and Lowe (1955) stated that the lecithoprotein in egg yolks aids as an emulsifying agent which according to Pyler (1952), exerts a tenderizing effect. When egg white or whole egg foam is added to the batter, it exerts a leavening action. Other characteristics attributed to egg are the mild, distinct flavor it imparts to cake, the distinct color, and its high nutritive value.

Fresh and frozen eggs are preferred to dried eggs for cake making (Lowe, 1955; Sweetman, 1954). Frozen eggs are used extensively in commercial baking and they seem to be a satisfactory substitute for fresh or stored eggs in most flour mixtures (Sweetman, 1954). Griswold (1962) recommended that for research on cakes, egg should be weighed instead of measured because of the great variations in the size of eggs.

Liquid, as described by several authors (Lowe, 1955; Peckham, 1969; Sweetman, 1954) has various functions. First, liquid is necessary to bring about hydration of the flour and egg proteins, giving the flour proteins cohesiveness and extensibility by the development of gluten. It also serves as a solvent for sugar, soluble salts, and the chemical leavening agent. During the heating process the liquid facilitates the gelatinization of starch.

Since liquid affects the hydration of starch and proteins it affects certain characteristics such as moistness or dryness of the finished product.

As reported by Peckham (1969), too little liquid results in a cake which is too dry and stales quickly, whereas, too much liquid produces a cake of small volume and very moist texture.

Fresh whole milk generally is used in cake making. However, Peckham (1969) and Sweetman (1954) agreed that evaporated, skim milk or non-fat dry milk solids with added water may be used. Milk is preferred to other liquids because of its nutritive value and its contribution to flavor and to browning during baking.

The function of leavening agents is to incorporate air in the batter and to make the baked product light and porous. The porosity of baked products have the following effects: (1) brings about good volume; (2) tenderizes the crumb; (3) imparts certain quality characteristics such as uniformity of cell structure, brightness of the crumb color, softness of texture and enhanced palatability (Pyler, 1952).

In cakes containing shortening practically all the leavening is done with baking powder. Pyler (1952) stated that double-acting baking powder is widely used in cake-making. West et al (1966) indicated that in large scale baking the delayed action makes it satisfactory for products that are held for a period of time before baking.

Balancing Cake Formulas

Pyler (1952) gave some rules in balancing the modern high-sugar, high-liquid cakes using superglycerinated shortening with high liquid and sugar-carrying capacity. The generalizations were as follows:

1. The weight of the sugar should exceed that of the flour.
2. The weight of the eggs should exceed that of the fat.
3. The weight of the liquid in the eggs and milk should equal or exceed

slightly the weight of the sugar.

Lowe (1955) suggested the following rules in balancing cake formulas based on rules given in bakery-made formulas:

1. The weight of the fat should not be over one-half the weight of the sugar.

2. The weight of the fat should not exceed the weight of the eggs.

3. The weight of the sugar should not exceed the weight of the flour.

4. The weight of the liquid (milk plus eggs, not weight of dried milk or egg) should equal the weight of the flour.

Coughlin (1942) stated that a balanced cake formula is dependent on the proper quantities and proportions of essential ingredients. Each ingredient exerts specific effects upon the characteristics of the final product. These ingredients perform counterbalancing functions. The toughening or binding ingredients should be counterbalanced by the tenderizing materials; the drying substances by the moisteners and vice-versa. Among the toughening or binding ingredients are flour, milk solids, egg white; the tenderizing agents are sugar, shortening, fat in egg yolks; the moisteners are fluid milk and egg; and the dryers are flour, sugar and dry milk. Pyler (1952) and Peckham (1969) agreed with the above and indicated that such a balanced formula will yield a cake of high quality that should be excellent in structure, volume, and keeping quality and palatability factors such as tenderness, moistness and good flavor.

Griswold (1962) emphasized the importance of the cake formula as one of the factors on which success in cake-making depends. Cranmore (1954) and Wenger (1953) also stressed the use of formulas for balancing cake recipes when quantifying and standardizing cake products. According to them, proper balance will prevent the loss of material, time, and labor in experimentation. Treat et al (1966) stated that because of the great range before "too much" or "too little" of an ingredient is reached such tolerance accounts for the large number of cake recipes that may produce an acceptable, if not, a perfect cake.

Measuring the Ingredients

Precise scaling or measuring of ingredients is the first basic step in production (Pyler, 1952). West et al (1966) and Vail et al (1967) pointed out that failure to weigh and measure accurately can result in an inferior product because balanced recipes may fail if correct measurements are not followed.

In a series of studies (Jackson, 1931; Monroe, 1931; Newbill, 1931; Welsh, 1931), it was found that weighing ingredients for institutional formulas is a practical and desirable way of securing a standard product. Treat and Richards (1966) emphasized the importance of weighing ingredients for attaining consistent quality products in quantity cookery.

Manipulation of the Cake Batter

Pyler (1952) and Peckham (1969) noted that the primary purpose of cake mixing is to bring about a uniform dispersion and blending of all ingredients and to incorporate the maximum amount of air in the batter. The procedure differs according to the type of cake.

Lowe (1955) described the different methods of mixing cake. She also identified the factors that affect the optimum mixing needed for plain cake and described the characteristics of cakes made from an optimumly mixed batter and those from undermixed and overmixed batter. Optimum mixing resulted in a cake with a rounded top, a good volume, tender, good texture, and good flavor. Overmixing produced a cake with a smaller volume, compact or solid and dull, smooth surface with small peaks. Undermixing resulted in a cake with coarse texture and less velvety feel than the standard cake, and the surface was almost level with a rough and glazy crust.

Baking Pan and Its Effect on the Baked Product

Lowe (1955) mentioned that the baking pan affects certain characteristics of the baked product. Peet and Thye (1955) reported that cakes baked in a pan with sharp corners tended to be browner at the corners. Lowe (1955) recommended the use of baking pans with straighter corners rather than those with sloped corners because it results in a cake with better texture.

Charley (1952) found that cakes baked in shallow pans were larger, more tender and had an evenly browned crust with flatter tops than cakes baked in deeper pans. In deep pans, the batter near the sides of the pan became firm early in baking while the center of batter expanded and resulted in a crack and the crust was browner. Peckham (1969) stated that the pan is the correct size when the cake just fills the pan without hanging on the side or bulging on the top. Lowe (1955) specified that the size of the pan should be such that the batter is at least 1- to $1\frac{1}{4}$-inch in depth in order to produce a cake with finer and more velvety texture.

In another study, Charley (1950) reported that cakes baked in faster-baking pans were larger in volume and had better crumb quality than those baked in slow-baking pans. Metals that are dark in color and/or dull like steel, japanned iron, anodized aluminum, and sheet iron were faster-baking than tinned iron, stainless steel, light aluminum or copper pans. Glass was found to require longer baking time than metal pans. Peckham (1969) recommended the use of aluminum pans because of the excellent heat distribution.

Lowe (1955) and Peckham (1969) advised that the pan be lined with waxed paper or greased to prevent sticking and, therefore, facilitate the removal of the cake. Cakes tend to expand to a better volume if the sides are not greased (Lowe, 1955).

Baking the Batter

Pyler (1952) and Peckham (1969) recommended that the batter be panned immediately after mixing. Prolonged standing causes loss of carbon dioxide and results in a baked product with coarse cell structure. Peet and Lowe (1937) reported that cakes are better when the batter is baked in a preheated rather than cold oven.

Peckham (1969) and Sweetman (1954) pointed out that the optimum baking temperature for shortened cakes varies according to the ingredients. The size and thickness of the cake also affects the baking time and temperature. Sweetman (1954) recommended an oven temperature in which the outer layer is not coagulated before the optimum leavening has taken place because such premature coagulation of the outer layer causes flatness and heaviness in the product and also results in a broken uneven top.

Pyler (1952) and Griswold (1962) stressed the importance of avoiding over-baking by keeping the baking time to a minimum. This will help to retain an optimum amount of moisture in the cake.

Characteristics of a Good Shortened Cake

West, Wood and Harger (1966) defined a good shortened cake as follows:

> A good shortened cake is uniform in thickness and attractive in appearance. The crust is delicate brown, tender, thin, and daintily crisp with no cracks. The cake should be light, tender, and agreeably moist, but not sticky. It should have an even, fine-grained texture and a delicate, well-blended flavor. An excellent shortened cake has the characteristics commonly spoken of as "velvetiness", meaning that to the tongue or fingers it feels like soft velvet. A cake with these characteristics is always light and has fine, even grain but these qualities do not ensure velvety feeling.

MATERIALS AND METHODS OF PROCEDURE

Preliminary Work

The proportions of ingredients for a 50-serving plain cake recipe expanded by Miller (1968) to 200 servings was used as the control recipe in the preliminary work (Appendix, Table 6). The original cake formula was from Fowler, West, and Shugart (1961) and was modified by Hurley (1958) to use nonfat dry milk.

For the present study, the procedure used by Miller (1968) was simplified by comparing the product from four different procedures with the control cake through visual evaluation. The procedure that resulted in a product comparable to the control cake was made three more times and compared with the control cake each time. When it consistently produced a good product after the three preparations, it was adopted as the control formula. The total mixing time was the same for the control and the simplified procedure. However, the number of steps were reduced from 14 to 7.

Weights of the ingredients from Miller (1968) were converted from the metric to the English system except for the liquid. The amount for each pan was five pounds. The baking time was adjusted, with two minutes added to the original baking time of 43 minutes.

The preliminary work consisted of baking 15 cakes to simplify and standardize procedures and to develop techniques for preparing the cake.

Formulas Used

The formulas used are given in Table 1. Formula I was the control with a yield of 50 servings. Formula II was eight times more than the control recipe

Table 1. Formula for plain cake.

INGREDIENTS	AMOUNTS Formula I	Formula II	Formula III	PROCEDURE
Cake Flour	1 lb. 9 oz.	12 lb. 5 oz.	15 lb. 7 oz.	Place in the mixing bowl in this order.
Sugar	1 lb. 14 oz.	15 lb. --	18 lb. 8 oz.	
Milk, non-fat dry	$2\frac{1}{4}$ oz.	1 lb. 2 oz.	1 lb. 7 oz.	
Salt	-- 1/3 oz.	-- 2 3/4 oz.	-- $3\frac{1}{2}$ oz.	
				ADD
Baking Powder	-- $1\frac{1}{4}$ oz.	-- 10 oz.	-- $12\frac{1}{2}$ oz.	Mix for 5 minutes at low speed (No. 1). Scrape.
Shortening	-- 10 oz.	5 lb. --	6 lb. 4 oz.	
Water	262.5 ml.	2,100 ml.	2,625 ml.	
				ADD
Frozen Egg	-- 8 oz.	4 lb. --	5 lb. --	Mix for 5 minutes at low speed. Scrape.
Vanilla	15 ml.	120 ml.	150 ml.	
Water	350 ml.	2,800 ml.	3,500 ml.	
				Mix for 5 minutes at low speed.
Number of Servings	50	400	500	

Pan size: 12 x 20 x $2\frac{1}{2}$ in. (rectangle)
Amount of batter per pan: 5 lb.
Baking temperature: 350°F
Baking time: 45 minutes

with a yield of 400 servings. Formula III was 10 times more than the control recipe with a yield of 500 servings.

Schedule of the Experimental Period

The first two periods of 12 baking periods served as pre-testing to determine the approximate time needed to prepare the three formulas continuously. This also introduced the judges to the use of the score card.

The main experiment consisted of 10 baking periods. Each baking period involved the mixing of two batches of Formula I and one batch each of Formulas II and III; and baking six cakes (two pans from each formula). A total of 60 cakes were baked for the entire experiment. The sequence of preparing the cakes is in Table 2.

Objective and subjective evaluations of the cake batter and the baked product were made for each baking period. A taste panel of 10 persons scored the products from each baking period.

Procurement of Ingredients

All the ingredients were purchased at the beginning of the study to have the ingredients for all the cakes as identical as possible. The ingredients purchased initially were two 100 lb. bags each of flour and granulated sugar. Other ingredients were two 10 lb. cans of double-acting baking powder; five 10 lb. cans of nonfat dry milk; one 100 lb. can of Kraft shortening; 1 gallon of pure vanilla extract; two 40 lb. boxes of frozen eggs; and two 1 lb. boxes of table salt. The liquid used was water.

Table 2. The sequence of preparing the cakes.

Baking Period	Treatments			
1	I	I	II	III
2	III	I	I	II
3	II	III	I	I
4	I	II	III	I
5	I	I	II	III
6	III	I	I	II
7	II	III	I	I
8	I	II	III	I
9	I	I	II	III
10	III	I	I	II

I - Control Formula, 50 servings
II - Eight times more than Formula I, 400 servings
III - Ten times more than Formula I, 500 servings

Storage of Ingredients

All ingredients except for the frozen eggs were stored at room temperature (72°F). Two covered stainless steel bins were used to store the opened bags of flour and sugar. The shortening, dried milk, baking powder, vanilla, and salt were kept in the original container. The boxes of frozen eggs were stored in the freezer (-10°F) and were allowed to thaw in the refrigerator (36-38°F) one day before each weighing period.

Weighing the Ingredients

All ingredients except the frozen eggs, shortening, water, and vanilla were weighed on a Toledo scale before the start of the experimental period. The flour, nonfat dry milk, sugar, salt, baking powder were placed in plastic bags that were tightly fastened. These dry ingredients were stored in a metal cabinet at room temperature (72°F) until the day of use.

Eggs and shortening were weighed each week. The eggs were placed in plastic bags and stored in the refrigerator until the day of baking. The shortening was scaled onto waxed paper, placed in plastic containers, and stored in a metal can at room temperature. Vanilla and water were measured with a 1,000 ml graduated cylinder at the start of every baking period.

Mixing the Batter

Before each mixing period, weights of the ingredients were re-checked. The ovens were turned on at the beginning of each baking period. Two different mixers with flat beaters were used. For Formula I a 20-quart Blakeslee mixer was used, for Formula II and Formula III a 60-quart Hobart mixer.

All mixing was done at low speed (mixer speed No. 1). For a scrape-down period, the motor was stopped and the mixer bowl was lowered. A scrape consisted of either one complete circular motion close to the sides of the bowl or one straight movement across the bottom of the bowl. A 10-in. flexible steel spatula was used to scrape the side and bottom of the bowl. Each side of the flat beater was scraped with a rubber spatula. Thorough scraping of the bowl was insured each time to help prevent the production of a lumpy batter from unmixed ingredients.

Flour, sugar, nonfat dry milk, salt, and baking powder were placed, in that order, in the mixing bowl. Then shortening and half of the water were added. The shortening was not added as a single block but was divided into six pieces for Formula I, 12 pieces for Formula II and 24 pieces for Formula III to insure even distribution and avoid lumps. These were mixed for five minutes and the timer on the mixer was used. After mixing, the batter was scraped using 10 strokes for the bowl and five strokes for the beater.

The egg, vanilla, and the rest of the water were blended with a wire whip and the egg-vanilla-water mixture was added to the first mixture. Mixing was resumed for five minutes, then the batter scraped, using 10 strokes for the bowl and five strokes for the beater. The batter was mixed for another five minutes.

During the last mixing period, pans were weighed and the oven temperature checked. The oven temperature was adjusted when necessary.

Continuous mixing of the batter was done during each experimental period, while one formula was being baked the next formula was being mixed. Four batters were mixed for each period; two for Formula I and one each for Formula II and Formula III.

Panning and Baking the Batter

The 12 x 20 x $2\frac{1}{2}$ in. aluminum pan was lined with parchment paper cut to fit the bottom of the pan. Five pounds of batter were scaled into the weighed baking pan and evenly distributed with a rubber scraper and baked 45 minutes at 350°F.

A revolving reel oven was used for baking the cakes. The baking compartment consisted of four shelves suspended in a ferris wheel style. The shelves revolved vertically and the direction of the rotation could be changed.

Evaluation

All tests for evaluation were done in the Institutional Management Research Laboratory with the exception of the subjective evaluation of the cake by a taste panel, which was done in the Organoleptic Laboratory of the Department of Foods and Nutrition.

Evaluation of the Batter

Consistency. Consistency was determined by the line spread test. This test consists of a line spread chart made of concentric circles drawn 1/8-inch apart. On top is a flat glass plate and a metal ring having the same circumference as the smallest circle. This is used to hold the batter. The distance between any three adjacent lines is equal to one centimeter. The metal ring is five centimeters in diameter and two centimeters in height.

The metal ring was placed on the glass plate over a line spread chart. The ring was centered on the innermost concentric circle of the chart and filled with 35 ml. of batter. The batter was levelled with a rigid steel spatula and the metal ring was lifted from the glass and allowed to flow for two minutes. The spread was read in four widely separated points on the outer edge of the material. Values were noted and the average of the four readings was recorded as the consistency of the batter. The higher value suggested less viscous batter. This test involves measuring the consistency of the batter in terms of its ability to spread on a flat surface (Griswold, 1962).

Evaluation of the Baked Cake

Two cakes were baked from each formula. One pan of cake was used for evaluating the shape and color of crust and the other one was cut and used for the other characteristics evaluated (Fig. 1). An 8 x 8 in. section was cut at

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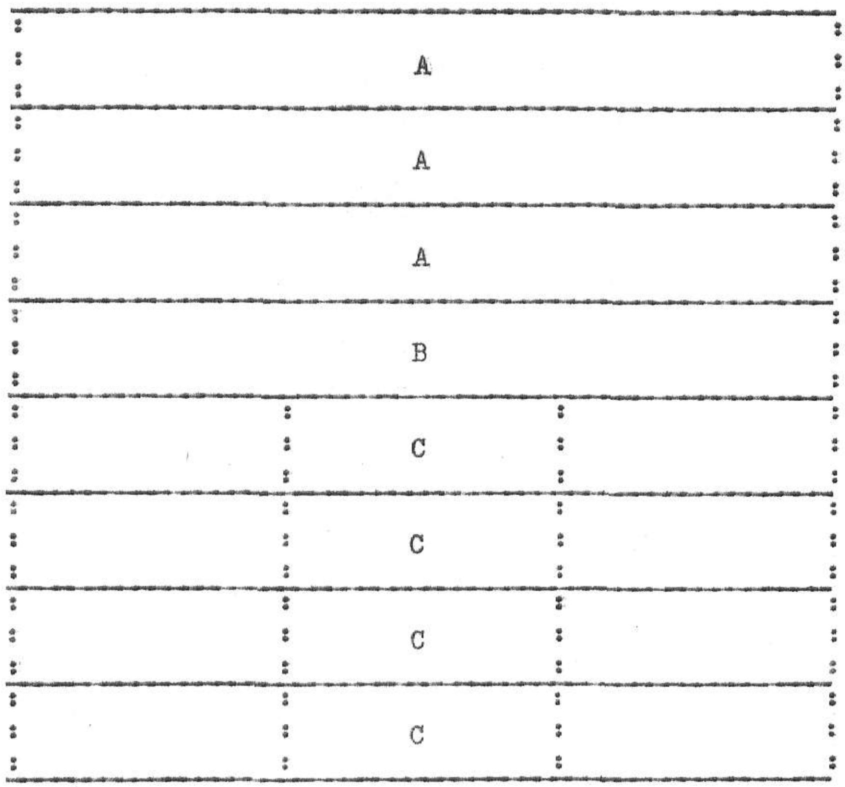


Figure. 1. Eight-inch square cut from the center of the cake.

A. Standing height measure.

B. Surface area of a slice measure.

C. Organoleptic evaluation.

the center of each cake with a cardboard frame as guide (Fig. 1). This square section was cut into strips of 1-inch thick. The first three slices were used for the standing height. The fourth slice was used for measuring the surface area of a slice and the last four slices were used for the panel evaluation.

Standing Height. The first three slices were traced on 13-lb. bond paper (Fig. 1). The height was measured two inches from each end and at the center of each slice (Fig. 2). The measurements from three different points were averaged to find the standing height of each slice. The average height of the three slices was recorded as the standing height.

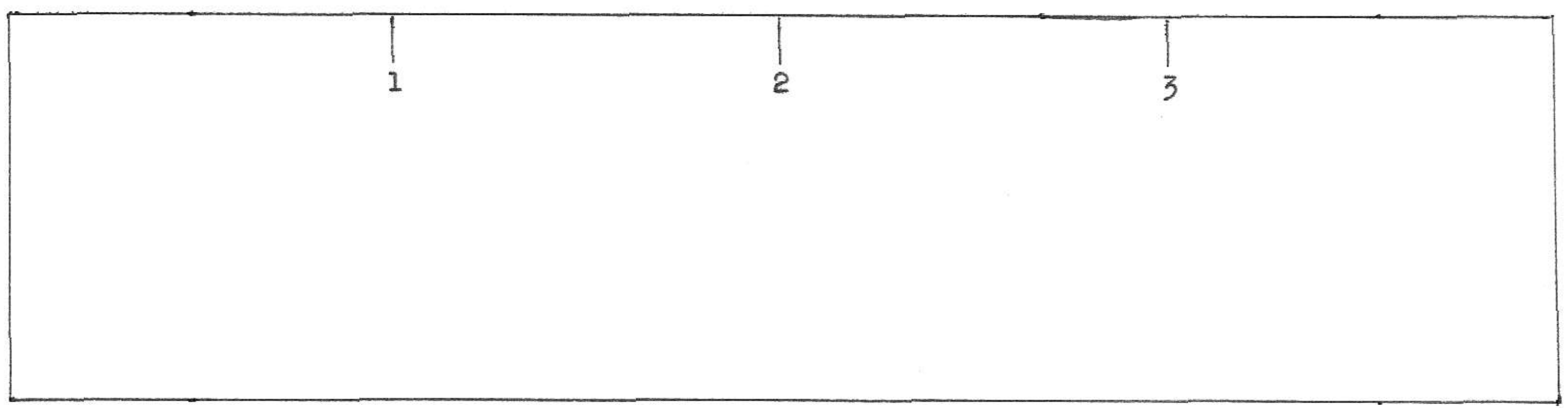
Area of the Slice. The fourth slice was traced on 13-lb. bond paper and the area was measured with a compensating polar planimeter. The area of a slice and the standing height were used as an index to the volume of the cake.

Subjective Evaluation. A taste panel composed of two faculty members, 4 graduate students, and 4 office workers evaluated the external and internal characteristics of cake samples. The rating scale ranged from 5, Excellent to 1, Unacceptable (Appendix, Table 7).

Ten samples were cut from each cake (Fig. 1). The three samples were placed on white dinner plates and were labelled 1, 2 and 3. The plates were covered with round aluminum baking pans to retard drying out of the cake slices. Evaluation was done in the afternoon at convenience of the committee members.

Statistical Design and Methods of Analysis

Analyses of variance were run to study the effect of quantifying a plain cake recipe on the viscosity of the batter and the volume and palatability



Positions 1, 2, and 3 were the three different points at which the standing height of a slice were taken. The average from these three points represented the standing height of a slice.

An 8-inch traced strip of cake, similar to the figure above was used also for measuring the area of a slice with a compensating polar planimeter.

Figure 2. An 8-inch traced strip of cake used for measuring the standing height.

characteristics of the cake. When significant differences occurred among the three treatments, least significant differences were computed at the 5% level.

RESULTS AND DISCUSSION

Observations

Certain observations that are possible guidelines were noted when a standardized 50-serving plain cake formula (Formula I, control) was quantified to give a yield of 400 servings (Formula II, 8 times more) and 500 servings (Formula III, 10 times more).

Simplified Procedure

During the preliminary work, it was observed that a simplified one-bowl method of mixing the cake blended the ingredients as well as the long dough-batter method.

Adding the liquid in two steps, the second part together with the eggs produced a less curdled batter than Miller's (1968) procedure. This agrees with the findings of Pyke and Johnson (1940) who reported that excellent cake was produced using the one-bowl method when the liquid was added in two steps rather than in one step.

Shugart (1962) suggested that when recipes are quantified adjustments may be needed in the time and temperature of cooking or in the mixing method. Griswold (1962) pointed out that presently the use of simplified methods of making cakes are emphasized to save labor especially with the use of electric mixers.

Mixers Used

It was noted in the present study and in the quantification work on two chocolate cake formulas (Felix, 1967) that the mixer size and efficiency affected the batter and consequently the baked cake. The size of the mixing bowl should not be too large or too small for the amount of the batter.

The 60-quart mixer was observed to be more efficient than the 20-quart mixer. A possible explanation is the difference in the shape of the bowl, the bowl of the 60-quart mixer has more sloped sides, whereas the bowl of the 20-quart mixer has straight sides (Fig. 3). According to Halliday and Noble (1946) and Vail et al (1967) a heavy mixing bowl with sloping sides and rounded bottom is more desirable than one that has straight sides. Aldrich (1955) and Wenger (1953) inferred that changes in mixing time, temperature and time of cooking may be needed when using large institutional equipment.

Scrape-down Procedure

The scrape-down procedure was important. It was necessary to insure thorough scraping of the mixing bowl especially the bottom part and the beater to help prevent the production of a lumpy batter.

No difficulty was encountered during the scrape-down procedure for the batter of the control cake (Formula I). However, more effort was required to scrape down the batter of the quantified formulas (II and III), which was also reported by Miller (1968).

Amount of the Batter

Aldrich and Miller (1963) recommended that after a recipe yield has been increased to 100 serving portions or to an amount close to 100, adjustment should be made for handling and/or cooking losses. An additional allowance of 3 to 5% of the batter was suggested.

During the two pretesting periods, the batters for the quantified formulas (II and III) were panned and resulted in the expected yield. Since the batter for Formula I (control) was not completely scraped from the mixing bowl, this

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60-quart Hobart Mixer

20-quart Blakeslee Mixer

Figure 3. The two mixers used.

provided for the handling loss and thus, may explain why it was not necessary to provide an additional allowance for handling losses for the quantified formulas (II and III). In another study (Felix, 1967), in quantifying a standardized 50-serving chocolate cake formula to 500 servings, it was found that with an additional two to four ounces of batter in the control formula it was not necessary to provide for handling and/or cooking loss for the larger quantities. In the same study, it was found that it is easier to expand a cake formula when the recipe has been standardized according to pan size.

Objective Evaluation of the Batter

The consistency of the batter was determined by the line spread test. The higher the line spread value, the thinner the batter. Formula I was thinner (P = 0.05) than Formulas II and III, which were the same in consistency (Table 3). Miller (1968) reported the same result in a similar study.

Table 3. Effect of quantification on the consistency of the cake batter.

Formula	Line Spread Value (cm.)
I	1.9
	*
II	1.7
III	1.7
	F-value = 26.7* LSD = 0.135

(Bracket with * links I and III.)

LSD, least significant difference, P = 0.05
*, P = 0.05

Lowe (1955) stated that for quantity baking, the amount of water or liquid must be decreased or when a small portion of the recipe is prepared the liquid is increased. Eliason (as cited by MacFarlane, 1959) contradicted this statement. In a recipe standardization and expansion program, she found it was not necessary to change the proportion of ingredients as long as the multiplication was correct up to the smallest fraction. Results of this study showed the batter consistency of quantified formulas (II and III) thicker than the control (Formula I).

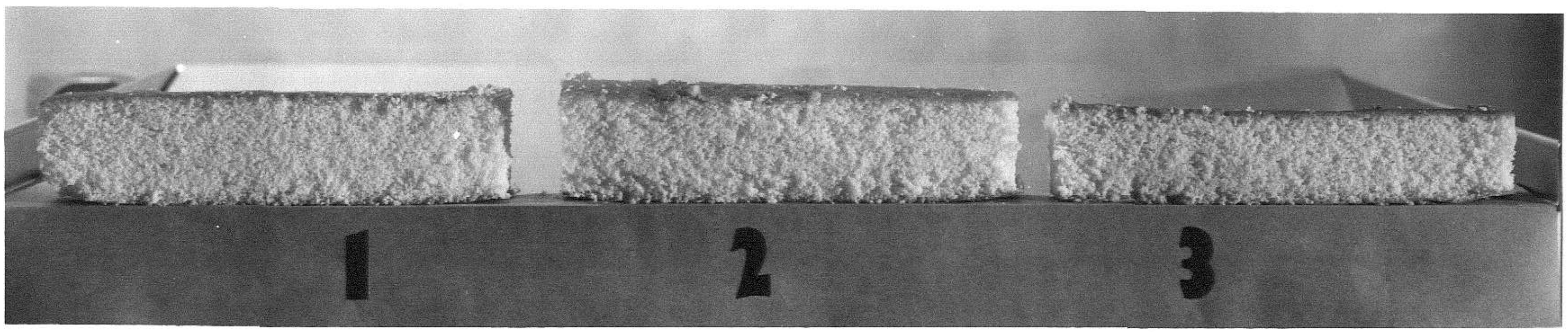
Pyler (1952) reported there is a wide range of viscosity values within which a satisfactory cake is produced and that cakes with viscosity values higher than the maximum range have coarser grain and texture. Lowe (1955) observed that a relationship existed between the batter and the baked cake. She commented that thin runny batters produced inferior cakes, whereas thick batters produced more desirable cakes. She indicated that these comments referred to batters in which the proportion of ingredients is balanced.

Hunter et al (1950) found that well-aerated batters tend to have relatively high viscosity and many small cells. They also indicated that such batters are likely to produce cakes of good volume and eating quality.

Objective Evaluation of the Baked Cake

The effect of recipe quantification on the volume of the baked cake was determined. The standing height and the area of a slice were used as indexes to the cake volume. Mean values from these measurements are presented in Table 4 and the detailed data are given in Tables 8 through 10 (Appendix).

Using the area of a slice as a measurement, significant differences in the volume of the baked cake were found between Formula I and Formula III and between Formula II and Formula III. The cakes made from Formulas I and II were slightly larger than the cakes made from Formula III, as shown in Fig. 4. Cakes



Formula I - Control (50 servings)

Formula II - 8 times more than the Control Formula (400 servings)

Formula III - 10 times more than the Control Formula (500 servings)

Figure 4. Cakes prepared from three formulas.

Table 4. Effect of quantification on the volume of the baked cake.

Formula	Standing Height (in)	Area of a Slice (sq in)
I	1.8	15.2 ┐
II	1.8	15.2 *
		*
III	1.8	14.9 ┘
	F-value = 0.29 ns	F-value = 9.93*
		LSD = 0.03

LSD, least significant difference, P = 0.05
*, P = 0.05
ns, not significant

made from Formulas I and II were about equal in volume.

Using the standing height as a measure for the volume of the baked cake, there were no significant differences among the samples.

Results of this study are contradictory to the findings of Hurley (1958) who reported that the thinnest batter gave the smallest volume of baked cake. The present study agrees with Tinklin and Vail (1946) who reported that in some cases, thin batters produced cakes of large volume and in other instances, cakes of small volume.

A possible explanation for the presence of significant differences (P = 0.05) among values for sq. in. (area of a slice), but not for in. (standing height) is that the compensating polar planimeter measures the entire shape, whereas, the standing height measures only three particular points in the cake. According to Griswold (1962), the use of a polar planimeter to obtain the area of a slice would give valuable comparison of similar products. She stressed the importance of using a slice representative of the product, such as the center slice.

Subjective Evaluation of the Baked Cake

A panel of 10 judges evaluated the external appearance and internal characteristics of the baked cake. A rating scale, ranging from excellent with a value of 5 to unacceptable with a value of 1 was used (Appendix, Table 7).

The shape and the color of the crust were evaluated from a whole cake placed under a MacBeth skylight. The other characteristics; namely, lightness, moistness, tenderness, grain, color of crumb and flavor were evaluated from a 1 x 1 x 1.5 in. sample of cake.

The standard cake was used as a basis for comparison. It was described as having a symmetrical shape with golden brown crust, free from spots and cracks. It is light in weight in proportion to the sample size. It is slightly moist, velvety and tender, but not crumbly. It has a fine grain with uniformly distributed cells having medium-thick cell walls. The color of the crumb is slightly yellow or creamy. The taste is bland and pleasant resulting from a good blending of the ingredients.

A summary of the mean scores for the factors evaluated is found in Table 5. The complete data are shown in Tables 11 through 13 (Appendix).

The shape, color of crust and lightness of the baked cake for the three formulas were rated as good. For the external appearance, statistical differences occurred in the shape between Formulas I and II and between Formulas I and III but not between Formulas II and III. The difference in shape was in favor of Formulas II and III, the quantified formulas. This is not a practical difference since the three formulas all were rated good. There were no significant differences among the formulas in the color of the crust and lightness.

The cakes had well rounded tops upon removal from the oven. After cooling the top flattened resulting in a slightly rounded top. The flattening of the

Table 5. Judges' mean scores for the external appearance and internal characteristics of the cakes made from Formulas I, II, and III.

Characteristics	Formula I		Formula II	Formula III	F-values	LDS
External Appearance						
Shape	3.9	*	4.2	4.2	10.93*	0.013
	└────	*	────	────┘		
Color of Crust	4.1		4.1	4.1	0.29ns	--
Lightness	4.0		4.0	4.0	0.22ns	--
Internal Characteristics						
Moistness	4.1	*	4.3	4.3	3.74*	0.121
	└────	*	────	────┘		
Tenderness	4.0		4.1	4.0	0.35ns	--
Grain	4.1	*	4.4	4.4	4.25*	0.127
	└────	*	────	────┘		
Color of Crumb	4.5		4.5	4.5	0.17ns	--
Flavor	4.3	*	4.5	4.4	2.77*	0.118
	└────	*	────	────┘		
General Acceptability	4.1	*	4.3	4.3	3.32*	0.106
	└────	*	────	────┘		

Score, 5, excellent; 4, good; 3, acceptable; 2, poor; 1, unacceptable
LSD, least significant difference, P = 0.05
ns, not significant
*, P = 0.05

top was observed also in other studies by Felix (1967). This may be the rectangular shape of the baking pan.

Some variations occurred in the symmetry of the cakes. The slanting position of the cakes may have been caused by the slanting position of the oven shelves. Some panel members commented that cakes made from Formula I tended to be more slanted than cakes made from Formulas II and III, which may be the fact that Formula I had a thinner batter consistency than Formula II and Formula III.

The pattern of browning of the crust of the cakes made from the three formulas was similar. Each cake had a golden brown border of about three inches on all sides and had a free form pattern on the center of the crust as shown in Fig. 5. A medium brown line separated the outer part from the rectangular area in the center. This area was darker brown in color than the border area. The judges were instructed that this browning pattern is normal and that it was not to be counted against the color of the crust when judging. There was no significant differences in the color of the crust among the formulas (Table 5). In institutional food services cakes are served usually with toppings or icings or sauces. Generally, the surface characteristics are of minor importance.

Lightness was evaluated by the judges as the apparent weight of a 1 x 1 x $1\frac{1}{2}$ in. cake sample in relation to its size. Analysis of variance showed no significant differences among Formulas I, II and III.

The internal characteristics evaluated, namely, moistness, tenderness, grain, color of the crumb, flavor, and general acceptability of the baked cake from the three formulas were rated good. The mean scores ranged from 4.0 to 4.5. Statistically, significant differences were found between Formulas I and II and Formulas I and III but not between the quantified formulas (II and III)

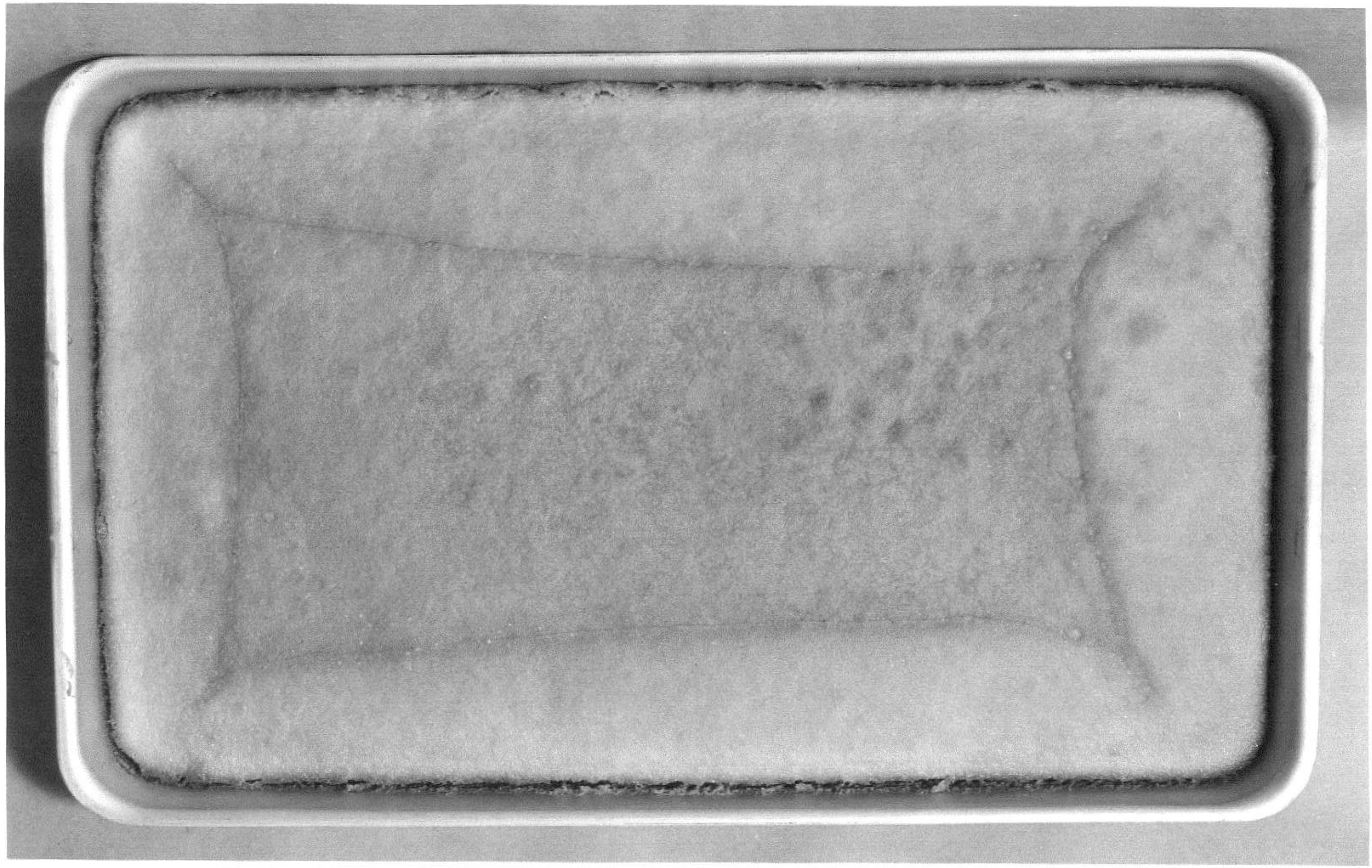


Figure 5. A whole cake showing the pattern of browning of the crust of all cakes made from the three formulas.

in the following characteristics: moistness, grain, flavor, and general acceptability. However, these statistical differences are not practical differences because the cakes from the three formulas were rated good and the differences in the mean scores were small. There were no significant differences among the three formulas on tenderness and color of the crumb.

The sequence of baking affected the moistness of the cake. The cake that was baked first appeared to be less moist than the cake that baked last. The order of mixing and baking for the 10 experimental periods was rotated for the three formulas (Table 2). To minimize drying out, the cake samples were cut at the same time and the plates were covered with round aluminum baking pans. Significant differences for moistness existed between Formulas I and II and Formulas I and III (Table 5).

During the pretesting periods, it was observed the cakes were tender and crumbly when hot. For this reason, the cake that was baked last was allowed to cool one hour before cutting. It was observed that the cakes baked first tended to be less tender than those that were baked last. The mean scores for tenderness of the three formulas were insignificant. All cakes were tender.

The grain of the cakes made from the three formulas was rated as good (4 points) by the judges. Formula I was significantly different from Formulas II and III, statistically. It was observed that as the cake cooled, the cells became smaller and more compact. One of the judges made the same comment on the score card.

By the color of the crumb, it was evident that the ingredients were well-blended in the cakes made from the three formulas. The color was slightly yellow or creamy because of the presence of egg yolk. The average values for the color of the crumb were the same for the three formulas.

Formula I was significantly different in flavor from Formulas II and III. Several judges commented that the three formulas tasted alike.

In the over-all acceptability, the cakes made from the three formulas were all acceptable and were given a rating of good (4 points) by the judges. Formulas II and III scored the same and were statistically different from Formula I.

Mean scores for the external and internal characteristics of the baked cake which included shape, color of crust, lightness, moistness, tenderness, grain, color of crumb, flavor, and general acceptability ranged from 3.9 to 4.5 on a possible 5.0-point scale (Table 5). The judges commented that there were no marked differences among the cakes made from the three formulas relative to the qualities evaluated.

SUMMARY

This study was undertaken to determine the effect of quantifying a standardized 50-serving plain cake formula on selected characteristics of the batter and the baked cake. On the basis of the results, certain guidelines for quantifying a plain cake recipe were established.

The control formula for 50 servings was designated as Formula I. Formula II was eight times more than the control formula giving a total yield of 400 servings; while Formula III was 10 times more than the control formula giving a yield of 500 servings.

Preliminary work was conducted to simplify and standardize procedures and also develop techniques for preparing and testing the product. The simplified one-bowl method for mixing was used. A total of 60 cakes were baked for the study. For each formula, five pounds of batter were scaled into a 12 x 20 x $2\frac{1}{2}$ in. aluminum pan and baked in a reel oven at 350°F for 45 minutes.

From observations, the simplified one-bowl method of mixing blended the ingredients as well as the long dough-batter method. A 60-quart mixing bowl with a sloped side was more efficient than a 20-quart mixing bowl with a straight side. The scraping procedure was important and evidently, scraping was more difficult with the quantified formulas (II and III). It was not necessary to adjust the amount of batter in the quantified formulas for cooking and/or handling loss.

A panel of 10 judges evaluated the baked cake. Data collected were subjected to an analysis of vairance to determine the effect of quantifying the standardized 50-serving plain cake formula on batter consistency; and the index to volume, shape, color of crust, lightness, moistness, tenderness, grain, color of crumb, flavor, and general acceptability of the baked cake.

The batter of Formula I was thinner ($P = 0.05$) than the quantified formulas (II and III), which were the same in consistency. The cakes made from Formulas I and II were slightly bigger in volume than the cakes made from Formula III.

The judges rated the cakes made from the three formulas as good (4 points) and even better than good in all characteristics evaluated. Statistically, significant differences were noted between Formulas I and II and Formulas I and III in the shape, moistness, grain, flavor, and general acceptability; however, they are not practical differences since all cakes were rated good. There were no significant differences in the color of crust, lightness, tenderness, and color of crumb. Generally, the cakes made from the quantified formulas (II and III) have had slightly higher mean scores than the control cake (I) in all the qualities evaluated. Average mean scores indicate a high quality cake from the three formulas. The results of this study are comparable to the findings of Miller (1968).

Based on the conditions of this study, quantification of a standardized 50-serving plain cake formula to 400 and 500 servings was done without difficulty and appreciable change in the external and internal characteristics of the cake; and the following guidelines for quantification of cakes are suggested: (a) development of a standardized 50-serving formula; (b) limiting the maximum amount to 500 servings or 10 times a 50-serving formula; and (c) simplification of procedures and the use of efficiency ingredients.

CONCLUSIONS AND GUIDELINES

Under the conditions of this study, the following conclusions may be drawn:

1. In the quantification of the plain cake formula, modification of the procedure used in the standardized 50-serving formula was the critical point. Having a good basic formula, expansion proceeded without problem.

2. A standardized 50-serving plain cake formula could be quantified eight and 10 times without appreciable change in the quality of the cake.

3. The simplified one-bowl method of mixing produced a cake of good quality.

4. No increase in the amount of the batter for handling and/or cooking loss was necessary when quantifying a standardized 50-serving cake formula.

5. Nonfat dry milk and frozen eggs may be used to produce a good quality cake in quantity baking.

Under the conditions of this study, the following guidelines are suggested:

1. It is recommended that in a quantification study of cakes, a basic step is the development of a standardized 50-serving formula. The written recipe should include size of mixer, mixing time, and mixer speed. The amount of the batter should be standardized according to the size of the baking pan.

2. In quantifying a cake formula, the maximum amount recommended is 500 servings or 10 times a basic 50-serving formula. Amounts larger than this are not recommended because of difficulty in mixing, scraping and handling.

3. In any standardization and quantification work, it is suggested that simplification of procedure and the use of efficiency ingredients be tried and evaluated. Efficiency ingredients such as nonfat dry milk and frozen eggs are recommended for quantity preparation of cakes; they are practical to use because of low bulk and ease of handling.

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APPENDIX

Table 6. Formula for plain cake quantified by Miller (1968).

Ingredients	Formula I	Formula II	Formula III	Procedure
Flour, cake (g)	709	1,418	2,836	Place ingredients in center of bowl in the order listed. Mix for 2 min in mixer bowl (low speed). Scrape down bowl 8 strokes and beater 6 strokes. Mix for 3 min more.
Baking powder (g) double-acting	27	54	108	
Dry milk (g) nonfat	72	144	288	
Shortening (g) hydrogenated	284	568	1,136	
Sugar (g)	850	1,700	3,400	Mix for 2 min (low speed). Scrape down bowl and beater. Mix for 3 min more.
Salt (g)	7	14	28	
Water (ml)	262.5	525	1,050	
Egg, Whole (g)	243	486	972	Divide each ingredient by weight and combine each half in separate containers. Add one portion of egg-liquid mixture; mix 30 sec. Scrape bowl and beater 8 strokes each. Mix for 1 min. Add second egg-liquid mixture, then mix for 1 min. Scrape bowl and beater 8 times each. Mix for 2½ min.
Water (ml)	350	700	1,400	
Vanilla	15	30	60	

Bake for 43 min at 350°F

Table 7. Score card for plain cake.

A. External Appearance

Qualities	Sample Number 1	2	3	Comments
SHAPE - symmetrical, free from cracks.				
COLOR OF CRUST - golden brown color, free from spots.				
LIGHTNESS - light in weight in proportion to the size of the sample.				

Rating Scale

5 - Excellent
4 - Good
3 - Acceptable
2 - Poor
1 - Unacceptable

B. Internal Characteristics

Qualities	Sample Number 1	2	3	Comments
MOISTNESS - slightly moist with velvety feel to the mouth.				
TENDERNESS - tender but not crumbly.				
GRAIN - fine, uniformly distributed cells with medium-thick cell walls.				
COLOR OF CRUMB - uniform and slightly yellow or creamy.				
FLAVOR - bland and pleasant. Well-blended ingredients.				
GENERAL ACCEPTABILITY				

Table 8. Mean values for batter consistency and index to volume of the baked cake made from Formula I.*

	Consistency	Index to Volume	
Baking period	Line spread (cm)	Standing height (in)	Area of a slice (sq in)
1	1.8	1.7	14.0
2	1.8	1.7	14.3
3	1.8	1.9	15.3
4	1.9	1.9	15.5
5	1.9	1.9	15.8
6	2.0	1.9	15.6
7	1.9	1.8	15.0
8	1.9	1.9	15.3
9	1.9	1.8	15.0
10	2.0	1.9	15.9
Average	1.9	1.8	15.2

*, Control Formula (50 servings)

Table 9. Mean values for batter consistency and index to volume of the baked cake made from Formula II.*

Baking period	Consistency Line spread (cm)	Index to Volume Standing height (in)	 Area of a slice (sq in)
1	1.8	1.7	14.1
2	1.7	1.7	14.4
3	1.7	2.0	15.8
4	1.7	1.9	15.5
5	1.7	1.8	15.0
6	1.7	1.9	15.9
7	1.7	1.8	15.3
8	1.7	1.9	15.7
9	1.7	1.8	14.7
10	1.7	1.8	15.1
Average	1.7	1.8	15.2

*, Eight times more than the control formula (400 servings)

Table 10. Mean values for batter consistency and index to volume of the baked cake made from Formula III.*

	Consistency	Index to Volume	
Baking period	Line spread (cm)	Standing height (in)	Area of a slice (sq in)
1	1.8	1.7	13.6
2	1.8	1.7	14.4
3	1.8	1.8	14.4
4	1.7	1.9	14.5
5	1.7	1.8	14.9
6	1.7	1.9	15.3
7	1.7	1.9	15.6
8	1.7	1.9	15.3
9	1.7	1.9	15.2
10	1.7	1.8	15.3
Average	1.7	1.8	14.9

*, 10 times more than the control formula (500 servings)

Table 11. Judges' mean scores for the cakes made from Formula I.*

Baking period	Shape	Color of crust	Lightness	Moistness	Tenderness	Grain	Color of crumb	Flavor	General acceptability
1	3.4	3.7	4.0	3.5	3.8	3.9	4.3	4.0	3.6
2	3.6	4.1	3.9	3.8	3.9	4.0	4.5	4.2	4.1
3	3.7	3.8	4.3	4.0	4.1	3.9	4.6	4.3	4.1
4	4.1	4.3	3.7	3.9	4.1	4.3	4.4	4.4	4.2
5	4.0	4.3	4.0	4.6	4.0	3.7	4.4	4.2	4.1
6	4.1	3.9	3.9	4.5	4.3	4.2	4.5	4.3	4.3
7	3.8	4.2	4.1	4.0	4.9	4.1	4.6	4.3	4.1
8	3.8	4.1	4.1	4.2	4.2	4.5	4.7	4.4	4.1
9	4.4	4.4	4.0	4.3	4.1	4.5	4.7	4.6	4.5
10	3.8	3.8	4.1	4.1	3.7	4.1	4.6	4.2	4.0
Average	3.9	4.1	4.0	4.1	4.0	4.1	4.5	4.3	4.1

*, Control formula (50 servings)
Range, 5 - excellent to 1 - unacceptable

Table 12. Judges' mean scores for the cakes made from Formula II.*

Baking period	Shape	Color of crust	Light-ness	Moist-ness	Tender-ness	Grain	Color of crumb	Flavor	General accept-ability
1	4.1	3.9	3.9	4.1	3.7	4.0	4.3	4.5	4.1
2	4.3	4.2	4.1	4.1	3.8	4.5	4.4	4.4	4.1
3	4.2	3.9	4.2	4.0	3.8	4.3	4.6	4.4	4.2
4	3.8	4.1	3.9	4.2	4.1	4.1	4.4	4.1	4.1
5	4.2	4.2	4.1	4.3	4.3	4.3	4.3	4.4	4.4
6	4.0	3.9	4.0	4.5	4.3	4.2	4.5	4.4	4.4
7	4.3	4.3	3.8	4.1	4.0	4.4	4.4	4.6	4.3
8	4.3	4.3	4.1	4.5	4.3	4.6	4.9	4.8	4.7
9	4.7	4.3	3.9	4.4	4.1	4.5	4.6	4.6	4.4
10	4.2	4.7	4.1	4.4	4.3	4.7	4.7	4.7	4.4
Average	4.2	4.1	4.0	4.3	4.1	4.4	4.5	4.5	4.3

*, Eight times more than the control formula (400 servings)
Range, 5 - excellent to 1 - unacceptable

Table 13. Judges' mean scores for the cakes made from Formula III.*

Baking period	Shape	Color of crust	Light-ness	Moist-ness	Tender-ness	Grain	Color of crumb	Flavor	General accept-ability
1	4.0	3.8	3.5	3.9	3.7	4.0	4.3	4.2	4.0
2	4.1	4.1	3.7	4.4	3.8	4.4	4.5	4.6	4.3
3	4.3	4.3	4.2	4.3	3.9	4.3	4.6	4.3	4.3
4	4.1	3.4	4.4	4.2	3.8	4.2	4.3	4.2	4.1
5	4.1	4.6	3.8	4.3	4.1	4.5	4.4	4.2	4.1
6	4.5	4.3	4.0	4.4	4.2	4.1	4.5	4.4	4.4
7	4.2	4.2	3.8	4.6	4.2	4.5	4.4	4.6	4.2
8	4.6	4.4	4.0	4.5	4.0	4.7	4.9	4.8	4.5
9	4.4	3.9	4.0	4.2	4.2	4.5	4.6	4.4	4.2
10	4.4	4.3	4.2	4.4	4.0	4.4	4.4	4.4	4.1
Average	4.2	4.1	4.0	4.3	4.0	4.4	4.5	4.4	4.2

*, 10 times more than the control formula (500 servings)
Range, 5 - excellent to 1 - unacceptable

DEVELOPING GUIDELINES FOR QUANTIFYING
A PLAIN CAKE RECIPE

by

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With the trend towards larger food service units, a need exists to establish guidelines that may be used for quantifying recipes. This study was undertaken to determine the effect of quantifying a standardized 50-serving plain cake formula on selected characteristics of the baked cake. On the basis of the results, certain guidelines for quantifying a plain cake recipe were established.

The control recipe for 50 servings was designated as Formula I. Formula II was eight times the control and Formula III was 10 times Formula I.

Preliminary work was conducted to simplify and standardize procedures and also develop techniques for preparing and testing the product. The simplified one-bowl method of mixing was used. A total of 60 cakes were baked for the study. For each formula, five pounds of batter were scaled into a 12 x 20 x $2\frac{1}{2}$ in. aluminum pan and baked in a reel oven at 350°F for 45 minutes.

Data collected were subjected to an analysis of variance to determine the effect of quantifying the standardized 50-serving plain cake formula on the batter consistency; and the index to volume, shape, color of crust, lightness, moistness, tenderness, grain, color of crumb, flavor, and general acceptability of the baked cake.

The batter of Formula I was thinner ($P = 0.05$) than the quantified formulas (II and III), which were the same in consistency. The cakes made from Formulas I and II were slightly larger in volume than Formula III.

The panel rated the cakes made from the three formulas as good (4 points on a 5 point scale) or better than good in all the characteristics evaluated. Statistically, significant differences between Formulas I and II and Formulas I and III were noted in the shape, moistness, grain, flavor, and general acceptability; however, all cakes were rated good. There were no significant differences in the color of the crust, lightness, tenderness, and color of the crumb. Generally, the cakes made from the quantified formulas (II and III) had slightly higher means than the control cake (I) in all the qualities evaluated. Average mean scores indicate a high quality cake.

Based on the conditions of this study, quantification of a standardized 50-serving plain cake formula to 400 and 500 servings was done without difficulty and without appreciable change in the external and internal characteristics of the cake; and the following guidelines for quantification of cakes are suggested: (a) development of a standardized 50-serving formula; (b) limiting the maximum amount to 500 servings or 10 times a 50-serving formula; (c) simplification of procedures and use of efficiency ingredients.