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BAKING FLOUR MIXTURES AT HIGH ALTITUDES

By Marjorie W. Peterson

Colorado Agricultural College
Colorado Experiment Station
Fort Collins

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PREFACE

The report of the investigation to date on the effect of high altitudes on baked flour mixtures is presented herewith in two parts. Part I (pages 5 to 138) gives an introductory discussion of the factors involved in the production of baked flour mixtures, a description of the altitude laboratory, discussion of baking experiments, a report of observations, discussions of results and summaries.

Part II, the supplement, is arranged for immediate use by the housewife and gives on pages 139 to 180 recipes for use at the following elevations: 3,000; 4,004; 5,000; 6,200; 7,360; 8,500; 9,820; and 11,180 feet above sea level. The recipes in the supplement have also been incorporated in a separate publication (Bulletin 366) for general distribution.

The basic recipes are for the following products: Popovers; baking-powder biscuits; muffins; butter cakes, including the 1-egg, 2-egg, 3-egg and 4-egg foundations and the chocolate, spice, white and gold cakes; angel-food cake and true and false yellow sponge cakes.

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BAKING FLOUR MIXTURES AT HIGH ALTITUDES

By Marjorie W. Peterson*

Ever since the early pioneers pushed their way westward into the Rocky Mountain region the women of families settling there have encountered food preparation problems characteristic of the higher elevations. It was at once discovered that to cook such staple articles of diet as potatoes and beans required a longer time than at lower altitudes. Much more disconcerting was it to find that the favorite cake recipes that had been followed so successfully in the old home, gave, in this new land, products heavy and coarse in texture. Differences in varieties of flour and sugar were among the causes credited with these failures. Yet there was available no certain knowledge with respect to modifications that would assure success.

Painstaking and persistent housewives, after many trials, came upon adjustments in the measurements of ingredients that gave satisfactory products. These revised recipes were generously made available with the result that in many a community the locally edited cookbook helped to meet the culinary difficulties. Thru such means, however, but a small fraction of the homes in the range of elevations materially affected—from 3,000 to 12,000 feet above sea level—were reached.

The continual influx of requests for advice on baking problems has resulted in a study of the role that altitude, or in other words atmospheric pressure, plays in the baking of flour mixtures. The problem undertaken was: (1) To understand as fully as possible the chemistry of the baking of flour mixtures and the part played by each factor; (2) to study how changes in altitude (or atmospheric pressure) affect the texture of cakes; (3) to arrive at adjustments in recipes for each 1,000 feet of change in altitude, from sea level to 15,000 feet above; and to give directions for baking these products.

EARLY WORK IN THIS FIELD

In the search of the literature for experimental data concerning flour-mixture products, one finds that only scant attention is given to quick breads and cakes as against innumerable publications reporting the vast amount of experimental work on yeast breads.

*Marjorie W. Peterson carried on the home economics investigations reported in this bulletin.

As early as 1908, Miss Mary F. Rausch, then head of the department of home economics at the Colorado Agricultural College, initiated the first experimental work in high-altitude cookery. President Charles A. Lory, professor of physics at that time, assembled for use in this initial set of experiments, a set-up consisting of an air pump, manometer, electric hot plate and a glass bell jar. Miss Inga M. K. Allison, an instructor in the department, was detailed to organize and carry on the project. The matter of the establishment of the curve showing the times required at different elevations for the cooking in water of such foods as eggs and potatoes was relatively simple. However, it soon became apparent that the device was inadequate for experimental work with flour mixtures at different altitudes. In 1909 the Journal of Home Economics[1] referred to this early attempt at inquiry into factors involved in the baking of flour mixtures at different atmospheric pressures.

This department has continued to be interested in the problem thru the intervening years but has had no wish to renew effort along this line until adequately equipped to proceed on a high research level.

A short article appearing in The Journal of Home Economics[2] for 1911 states that the experience of those living at high altitudes is, that in baking cake one should use less egg, less fat, less sugar and a smaller proportion of soda to cream of tartar. Paul Richards is quoted in that article as saying that in Denver the successful recipes used by bakers contained less sugar, baking powder and ammonium bicarbonate and in some cases more flour. These statements were based on general experience, not on carefully controlled experiments.

Miss Jessie Whitacre,[3] working at the Utah Agricultural College in 1922, at an altitude of 4,800 feet, found that the following sea-level recipe produced a cake which was coarse grained and had a speckled, waxy, sugary crust:

1/3 cup butter	1/2 cup milk
1 cup sugar	1 3/4 cups flour
2 eggs	2 1/2 teaspoons baking powder
1/4 teaspoon salt	

A decrease of 5 tablespoons in sugar (33 percent), 2 tablespoons in flour (7 percent), and an increase of 2 tablespoons of butter (33 percent), produced a successful product.

From experiments carried on at the University of Wyoming at an altitude of 7,200 feet, by Miss Elizabeth J. McKittrick[4] in 1923, the conclusion was drawn that, for a plain cake a reduction of 33⅓ percent in baking powder was the only adjustment necessary. In richer cakes the best results were obtained by a reduction of 16⅔ percent in butter, 12½ percent in sugar and 25 percent in baking powder.

More recent experiments on 30 cakes, carried out by Carmen D. Fredrickson and Carrie C. Dozier[5] at the Utah Agricultural College in 1928, show results quoted below. The recipe used was:

½ cup butter or	½ cup milk
5/12 cup vegetable fat	1⅔ cups flour plus 3 tablespoons cornstarch
1 cup sugar	3 teaspoons baking powder
2 eggs	1 teaspoon vanilla
½ teaspoon salt	

The cakes made from this recipe were heavy, sunken and coarse. The crust was shiny and speckled and with a butter flavor.

The following recipe was the one adopted after correction:

⅓ cup vegetable cooking fat	¾ cup milk
1 cup less 2 tablespoons sugar	1⅔ cups flour plus 3 tablespoons cornstarch
2 eggs	3 teaspoons baking powder
½ teaspoon salt	1 teaspoon vanilla

This is a decrease of 20 percent in fat, 12½ percent in sugar, and an increase of 50 percent in milk. They also report that a reduction of baking powder was tried but that the result did not justify this change.

The foregoing data are based on experiments performed at a single elevation with the purpose of determining corrections in a definite recipe which should produce an acceptable product. Where percentages are given they hold true only for that particular recipe. These experiments were not carried on at other altitudes, employing the same utensils, the same kinds of ingredients, and by the same persons; so that in each study reported the modification cited is true only for that particular recipe at that particular elevation.

Work of a slightly different nature was conducted by Miss Anna Steckelberg of Western State College, Colorado. However, the only published records[6a] of this work found to date are a brief mention to the effect that there had been completed a 4-year study on cakes at the following altitudes: Sea level, 1,500, 3,000, 4,500, 5,000, 7,800, 10,000 and 14,000 feet. A short popular article[6b] by Miss Steckelberg states that a decrease in sugar of 2 tablespoons per 1,000 feet is the only change in proportion required and that a slight increase of baking temperature of 2 degrees F. or 3 degrees F. per 1,000 feet, is advantageous; a pamphlet has been published by a commercial firm[6c] giving recipes with the adjustments for 3,000, 5,000 and 7,500 feet for five cakes.

A careful study of the foregoing experiments indicated the following facts: They were limited both as to the number and as to the type of flour mixtures investigated. Except in the work of Miss Steckelberg they were carried out at a single elevation.

Since the number of variables in any set of baking experiments are many and must be accurately controlled if the results are to serve as a guide to general practice, it was decided that an attempt at a more extensive study of the problem was justified.

It was obvious that in order to approach the problem scientifically it would be necessary to have a specially constructed baking laboratory in which the atmospheric pressure could be adjusted to that corresponding to any altitude and maintained constant while the worker weighed and mixed the ingredients, baked and cooled the product being studied. The altitude laboratory, described on pages 11-25 was constructed, and the investigation, herein reported, was carried on by the Home Economics Section of the Colorado Experiment Station during the years 1926-28.

ATMOSPHERIC PRESSURE

The expression "atmospheric pressure" will occur so frequently in this report that discussion of its measurement and of its significance in cookery is pertinent.

The weight of the air or atmosphere above the earth's surface is known as the pressure of that atmosphere upon the earth, or as atmospheric pressure. Just as the pressure of water is greatest at the bottom of the sea and becomes increasingly lighter as one approaches its upper surface, so in this "sea of atmosphere" upon the earth, the pressure of the air is greatest at the surface of the earth and it becomes increasingly lighter as one goes up, as when one climbs a mountain or makes an ascent in an airplane.

This atmospheric pressure is measured by a barometer. At sea level it exerts a pressure of 14.7 pounds per square inch, or this measurement may be given in terms of the height of a column of mercury which the atmosphere is capable of holding up, viz. 29.92 inches (or 76.0 cm.) of mercury. As one ascends into the air this pressure constantly decreases, being approximately

12.28 pounds per square inch, or 25 inches (63.52 cm.) of mercury at 5,000 feet altitude, and 10.26 pounds per square inch or 20.9 inches (53.08 cm.) of mercury at an altitude of 9,820 feet. This atmospheric pressure usually varies slightly from day to day due to weather changes. *The average atmospheric pressures corresponding to various altitudes adopted for the work in the project are shown in Table 86, the atmospheric pressure being given in inches of mercury and the corresponding altitudes in feet.*

Cooking processes, especially those involving boiling, are affected by the atmospheric pressure, altho the housewife is often not cognizant of this fact. A simple example is that of water, or of any other liquid, which boils when its vapor pressure is equal to that of the surrounding atmospheric pressure. Thus at sea level where the atmospheric pressure is 29.9 inches of mercury, water will boil when heated to 212 degrees F. (100 degrees C.), but if the atmospheric pressure is only 24.9 inches of mercury as at 5,000 feet, water will boil when heated to only 203 degrees F. (95.0 degrees C.). Candy and icing recipes frequently state that a sugar syrup should be boiled to a certain temperature, but the corresponding atmospheric pressures are not given. This accounts for the fact that these products made at altitudes different than sea level, or made on sunny and rainy days are not always identical. Accurate results may be obtained if the atmospheric pressure is known and the temperatures corrected accordingly. Since the boiling point of water is dependent upon the atmospheric pressure, one may know the barometric reading by taking the boiling point of water and consulting Table 86 on page 133.

The influence of atmospheric pressure upon the baking of flour mixtures is a much more complex problem than the above, for there are many factors involved. The relation of it to the formation and expansion of the gases employed as leavening agents is of chief importance. Of the three gases employed as leavening agents—air, steam and carbon dioxide—the air is incorporated into the batter by volume and not by weight. Tho the weight of the volume of air in the batter will vary with the atmospheric pressure, the volume of the incorporated air will depend upon the manipulation and not upon the atmospheric pressure. Steam used as a leavening agent is obtained from the liquid ingredients in the batter, and the carbon dioxide is obtained from the baking powder or soda. The volumes of steam and of carbon dioxide obtained from given weights of their respective sources are dependent upon the existing temperature and pressure. Charles' and Boyle's laws state respectively that the volume of a gas is directly proportional to its absolute temperature and inversely proportional to the pressure. To illustrate: Each cubic centimeter (cc.) of air incorporated into a batter at room temperature, 20 degree C. or 68 degrees F., expands to 1.6 cc. at 205 degrees C., or 400 degrees F., at every atmospheric pressure since the pressure is a constant thruout the process. One cc. of water added to a batter at 20 degrees C. (68 degrees F.) will produce 2,173.2 cc. of steam at 205 degrees C. (400 degrees F.) if the atmospheric pressure is 76 centimeters or 29.9 inches of mercury. Under an atmospheric pressure of 63.3 cm. or 24.9 inches, the same weight of steam will occupy 2,609.2 cc. at 205 degrees C. which is an increase of 20.06 percent in volume.

The same thing is true of carbon dioxide (CO_2). One gram of carbon dioxide (CO_2) produced at 0 degree C. (32 degrees F.) occupies a volume of 509.1 cc. at a pressure of 76 cm. This amount expands to 891.4 cc. at 205 degrees C. (400 degrees F.) at this pressure, but if the pressure is 63.3 cm. the volume occupied is 1070.25 cc. which is, of course, the same percentage gain as for steam. Upon decreasing the pressure the same amount again, 5 inches or 12.6 cm. of mercury, it is found that 1 gram of steam or of CO_2 occupies 25.09 percent more volume than at 24.9 inches (63.3 cm.) and 50.2 percent more than at sea level.

From the standpoint of theory it would seem that a correspondingly smaller weight of CO_2 would be required to perform the same amount of work as the atmospheric pressure decreased. This was found to be approximately true. It might also seem that there should be the same decrease in the amount of liquid, but the function of the liquid, except in the case of popovers, is not primarily one of leavening and there are other factors involved so that this was not found to be the case. There must be sufficient liquid for the solution of all soluble substances and to serve as a medium for the dispersing of all the other ingredients. Also, since the rate of evaporation of the liquid is greater at reduced pressures, there must be enough moisture remaining in the product to prevent it from becoming dry and crumbly.

Better results have been secured with the reduction of sugar and fat as well as carbon dioxide—at reduced atmospheric pressures. No experimental evidence is available to explain the fact adequately. A suggested interpretation is, that the liquid at the reduced pressures evaporates to a greater extent, which causes the sugar solution to become more concentrated. With increased internal pressure the tiny cells are ruptured, allowing more of this very concentrated solution to collect. It has been shown that the sugar solution and the fat prevent the gluten strands from adhering as firmly as they would if these substances were not present, thus weakening the structure. By reducing the amount of these substances the structure would be strengthened and more able to resist the increased internal pressure. Also there would be less of these materials to collect in the holes formed by the ruptured cells. It would seem that the greater evaporation of the water and concentration of the sugar solution could be the only direct effect of reduced pressure upon the sugar and that its influence in the baked product would be secondary.

To sum up briefly, there should be a decrease in the internal pressure of the product by a decrease in the source of the carbon dioxide and an increase in the tenacity of the gluten by decreasing the amount of fat. A reduction of sugar will aid this increase in tenacity and produce a less concentrated sugar solution in the product.

DESCRIPTION OF ALTITUDE LABORATORY AND EQUIPMENT*

In designing the altitude laboratory the first problem to be solved was the size, shape and material of the laboratory itself. From the standpoint of equalizing the material stresses both for pressure and vacuum operation, the best shape would be spherical. But this shape would be impractical, therefore the cylinder standing on one end was chosen as the most suitable form. For a single operator and the necessary inside equipment such as electric range, cabinet, small table, chair and ice box, it was decided that a cylinder 7 feet in diameter and 9 feet in height would suffice.

In deciding upon the material a more difficult problem was encountered. For a steel tank, with pressure inside, the thickness need be only about .01 inch, but for a vacuum inside no satisfactory information could be found. Government specifications, boiler codes, etc., for external pressures (or relative inside vacua) cover cylinders only up to about 4 feet inside diameter. Everyone knows that a paper bag may be blown up to a considerably high pressure inside, but that the slightest suction applied inside causes it to collapse instantly. A large, thin, steel cylinder acts exactly like the paper bag. The slightest eccentricity or deviation from perfect circular form tends to cause collapse when subjected to external pressure. Hence it appeared that a concrete cylinder with 6-inch walls would be more suitable as concrete is

*Written by Professor J. Harry Scofield, of the Mechanical Engineering Department, who designed and built the laboratory.

high in compressive strength and not elastic like steel, yet for other reasons, boiler-plate steel was decided upon. The cylinder walls were made 3/16 inch thick and the two heads, 1/4 inch thick. This was several times the needed strength by the nearest applicable authority. The upper head was domed outward about 1 foot and the bottom head inward a like amount. A level wooden floor was built upon the bottom dome.

The doorway was made small, 18 by 24 inches, in order not to weaken the cylinder wall any more than necessary. It was previously determined that the electric range to be used could be taken apart and would pass this size doorway. The doorway was faced with a steel band or jamb 1/2 inch thick and 3 inches wide, protruding about 1 1/2 inches outward and 1 1/2 inches inward. Two doors were made of steel and mounted, one outside and one inside the cylinder to fit against the outer and inner edges of this steel jamb. A soft rubber gasket was fastened to each door to make the joint air tight. Toggle hinges were used on the doors to permit perfect adjustment against the jambs. A short shaft was run thru the cylinder walls and made air tight by a packing gland. Two levers or handles about 3 feet long were keyed to this shaft, one lever outside and one inside the cylinder. An inclined plane or steel wedge was welded on the outside of either door. When the two doors are closed and this pair of levers is pushed down against the wedges by either the outside or inside operator, the doors are made to close tightly. When there is pressure inside the cylinder the inner door becomes tighter with increase in pressure. When there is vacuum (or a pressure less than atmospheric) inside the cylinder the outer door holds.

The entire cylinder, with doors and hinges, was made by electric welding by the Eaton Metal Products Company of Denver, Colorado. This cylinder, which is variously called "the tank," "altitude laboratory," "altitude room" and "variable altitude laboratory," was placed at the west end of a big south porch at the Home Economics Building. A concrete foundation and brick work were used to close the tank up tightly against the building and porch. The door opens out upon the porch as shown in the accompanying photograph, Figure 4. A window was placed in a big archway of the porch and also a cross partition with a door. Thus the west end of the porch was turned into an anteroom leading to the altitude laboratory. This anteroom or outer room was used to house the machinery to produce the altitude effects. During the research work one girl occupied this machinery room to operate the motor, blower, regulator weights and water cooling. By the use of a very little extra equipment, arrangements could be made which would enable a single operator in the laboratory to operate all the machinery in the outer room, but it was considered advisable to have the outside operator at hand every minute as a precaution against any unforeseen emergency.

The altitude laboratory is not considered a dangerous place for a healthy individual with a normal heart. The motor and blower (compressor) used are capable of duplicating altitudes only from about 4,000 feet below sea level to about 18,000 feet above sea level. The technician was taken from one extreme to the other in less than 15 minutes without any noticeable effect except a slight ringing noise in the ears due to the rapid change when coming down. However, every precaution was taken in the interest of safety. The inside operator could stop the motor and blower, open the special vacuum relief valve or a special globe valve to allow the pressure to become equal to atmospheric. After this she could easily open the doors by using the inside door lever mentioned above. No combustible materials were used inside the laboratory except the floor and cabinet. Electric light and electric range were used. Gas would not be satisfactory as the fumes would be dangerous to the operator.

The greatest source of danger is the possibility of a sudden breakage of one of the three small windows (5-inch diameter plate glass) causing a sudden rise or drop in pressure. Even this should cause no very serious trouble as the pressure change could not be more than about 5 pounds per square inch, which is about the limit of the blower capacity. For the highest altitude contemplated for the experiments, about 14,000 feet above sea level, the pressure is only 3.43 pounds below Fort Collins atmospheric pressure. An interesting comparison would be to note that lying on the bottom of an 8-foot depth of water is like going to a 9,000 foot lower altitude, so far as pressure is concerned.

No attempt was made to attach to the altitude laboratory an entry and exit chamber. This could be done with no very great additional cost by simply welding to the tank a small steel compartment surrounding the present double doors and attaching to the compartment another pair of doors similar to those now in use. This compartment would permit one to enter or leave the laboratory without disturbing the pressure or experiments going on within. The desirability of this attachment was not considered great enough to justify the additional cost. However, it can be added at any future time if the nature of the experiments within requires entry and exit while experiments are going on.

While the experiments described in this bulletin were being carried out the technician usually entered the laboratory at 8

a. m. and worked till 12 noon at whatever altitude she desired. Then the process was repeated from 1 p. m. to 5 p. m. Having all the materials inside made it unnecessary to leave the laboratory till an experiment was finished or a half day's work done. However, the change from Fort Collins atmospheric pressure to sea level pressure or to 10,000 feet altitude pressure required only 2 or 3 minutes and to 14,000 feet altitude, only about 5 minutes. Hence, at the end of any experiment she could very quickly produce conditions for leaving the laboratory and re-entering. This quick-change feature entirely relieved her from the feeling of being in jail while working in the laboratory.

EQUIPMENT FOR VARYING PRESSURES

Having decided upon the size, shape and material for the room or laboratory itself, the next problem was to settle upon the equipment to be used for producing in the laboratory the pressures from sea level (or below) to Fort Collins altitude of 5,000 feet above sea level, and also for producing all the lighter pressures or partial vacua to represent the various higher altitudes up to 14,000 feet or higher. At the same time that any one of these several pressures was being maintained in the laboratory, there must be a constant flow of fresh air into the laboratory and of used air away from it without disturbing the desired pressure within.

The original proposal provided for a motor-driven compressor to discharge high-pressure air into a receiver and this air was to pass thru a reducing valve into the altitude laboratory. It also provided for a motor-driven vacuum pump to produce the higher-altitude effects. The high-pressure idea was quickly discarded as being dangerous as a source of supply of breathing air for a person within the laboratory. Should the reducing valve or relief valve stick or fail in any way, the person might be injured. Instead, a rotary blower was selected, which cannot give pressures above 5 pounds per square inch. This pressure maximum is about like being under 11½ feet of water, or practically nothing, and is entirely safe regardless of what might happen to the motor, blower or relief valves. Thruout the entire range of altitude from 4,000 feet below to 14,000 feet above sea level, the person in this altitude laboratory is practically unaware of any pressure or vacuum effect. Besides discarding the high-pressure-receiver idea, the vacuum pump and motor were eliminated, and the blower used to produce pressures was also used to produce the vacua for altitudes higher than Fort Collins.

Heating and ventilating engineers agree fairly well upon 1800 cubic feet per hour or 30 cubic feet per minute as the amount of fresh air which should be supplied at sea level to a room in which one average adult is engaged in light work. The weight of this volume of air at 62 degrees F. is 136 pounds per hour or 2.25 pounds per minute. Of course, the individual does not actually breathe all this air, but it is desirable to keep the exhaled CO_2 (carbon dioxide) percentage down to a certain point, and hence, the seemingly extravagant quantity of fresh air supplied.

While it is very convenient to give the measure of air in cubic feet at or near sea level, the same weight of air at any other level or any other pressure will have a volume different from its volume at sea level. For any given atmospheric temperature at both levels or both pressures a given weight of air will have volumes inversely proportional to the pressures. In other words, if we double the pressure on a given amount of air and allow the temperature to drop to the original point the volume will be just half the original volume. This refers to what we call "absolute pressures." By absolute pressure we mean simply atmospheric pressure plus gage pressure. At sea level the atmospheric pressure is 14.7 pounds per square inch, even tho we are not conscious of this pressure as we move about in the atmosphere. Hence, if a steam gage reads 5 pounds pressure, the absolute steam pressure is 14.7 plus 5 or 19.7 pounds per square inch absolute, at sea level. Knowing the mean barometric pressures for all altitudes, we may readily compute the volume to which 30 cubic feet of sea-level air would expand if it were moved in a container to some higher altitude and allowed to assume the new lighter atmospheric pressures.

The following tabulation shows the atmospheric pressures and the volumes required per minute for one adult at several convenient altitudes, also the plus or minus pressures compared to Fort Collins atmospheric pressures:

Altitude in feet	Atmospheric pressure. Lbs. per sq. inch	Volume of air required for one person per minute in cubic feet	Atmospheric pressure difference from Fort Collins atmospheric pressure. Lbs. per square inch
0—Sea Level	14.7	30	+2.42
5,000—Fort Collins	12.28	36	0.00
10,000—Grand Mesa	10.2	43	—2.08
14,000—Snowmass Peak	8.85	50	—3.43

These calculations indicate that at Fort Collins, or at any other place of 5,000 feet altitude, an individual working in a room should be supplied with 36 cubic feet of fresh air per minute; at 10,000 feet, 43 cubic feet and at 14,000 feet (near the top of Pike's Peak), 50 cubic feet. Here we may well note in passing why it is, that we breathe so deeply or more rapidly in the higher altitudes. We must inhale ⅔ more air at 14,000 feet than we do at sea level, 50 cubic feet in the place of 30 cubic feet.

Authorities differ slightly on the values of barometric pressures at the various altitudes, but these differences are slight and easily accounted for. Pressures vary slightly from day to day at all places on the earth due to weather changes. The mean pressure over a period of time is the pressure used and this mean would naturally differ at two places of the same altitude if their mean weather conditions differ. These disagreements are not sufficiently great to affect this problem, and the pressures shown in the above tabulation are sufficiently accurate to be used for baking purposes anywhere at those levels. Anyone wishing to compute the mean atmospheric pressure at his own altitude may do so by using the following equation:

$$A = 14.72 - \frac{57{,}000\ N - N^2}{100{,}000{,}000}$$

in which A is atmospheric pressure in pounds per square inch and N is his own altitude in feet above sea level. Divide A by 0.491 if it is desired to compute the barometric pressure in inches of mercury.

Interpreting the pressures in the above tabulation for use with this altitude laboratory, it may be noted that at Fort Collins, where the altitude is 5,000 feet and the atmospheric pressure 12.28 pounds per square inch, there must be produced in the laboratory a pressure which will read 2.42 pounds per square inch on a pressure gage placed outside the laboratory to reproduce sea-level altitude inside the laboratory. (12.28+2.42=14.7 pounds per square inch absolute.)

At 10,000 feet the atmospheric pressure is 2.08 pounds per square inch less than at Fort Collins, hence, there must be produced in the laboratory a vacuum or negative gage pressure which will read 2.08 pounds vacuum or 4.24 inches of mercury vacuum on a gage placed outside the laboratory, and having its pressure tube run into the laboratory. For 14,000 feet the gage reading outside the laboratory is 3.43 pounds vacuum or 7 inches of mercury vacuum. Similar computations will show the desired gage readings for any desired altitude.

Coming now to a description of the equipment and how it works, starting with the blower, after a careful study of several types and makes on the market a Connersville type 17B was selected as most nearly fitting the needs. It works about like the ordinary gear pump commonly used in automobile crank cases for pumping oil to the engine parts. Instead of having 2 gears it has 2 impellers shaped about like a Figure 8. The accompanying Figure 1 shows diagrammatically how the blower works. The air comes in thru a pipe which screws into the bottom. Both of the figure-8 impellers turn outward at the bottom. Each impeller traps a pocket of air coming in at the bottom and carries it around near the outer edge of the case and delivers it at the top where it is discharged into an outlet pipe. Figure 2 shows how the blower looks inside. The inlet pipe at the bottom takes in air from the atmosphere, when running "on pressure" for lower altitude conditions, and delivers it into the altitude laboratory. The air continually pouring into the laboratory causes the pressure to rise to the desired point when a pressure relief valve opens and allows the air to escape continuously from the laboratory. When running on vacuum for higher altitude conditions, the inlet pipe at the bottom of the blower draws air away from the altitude laboratory and delivers it out into the atmosphere. As the air is continually drawn out of the laboratory the pressure in the laboratory will drop to the desired point when a vacuum relief valve opens and allows fresh air to escape continuously from the atmosphere into the laboratory. This complete shift from running on pressure to running on vacuum is accomplished by simply turning two three-way cocks which will be shown later. The blower will again be seen in Figures 3 and 4.

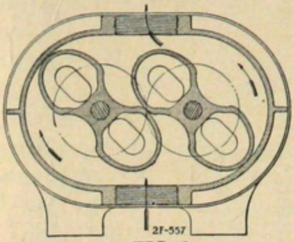

FIG. 1

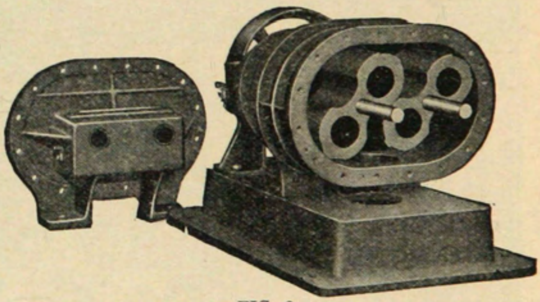
FIG. 2

Referring now to Figure 3, the motor which drives the blower will be seen on the extreme right. It is a General Electric Type B S R variable speed, 1½ horse power, 220 volt, alternating current, 60 cycle, single phase motor. By means of a brush shifting arrangement, it is possible to obtain any desired speed from 720 to 2000 revolutions per minute. This type motor costs more than the simple induction motor, but the blower speed variation is necessary in order to obtain the various desired volumes of air for correct ventilation. The speed is controlled by shifting a small lever shown in Figure 3 at the extreme right of the motor. A small pointer was attached to this lever and a brass scale graduated in 32nds of an inch was attached to the frame of the motor and directly under the pointer. By means of a sheet of test curves furnished by the blower manufacturer, it was possible to determine at what speed to run the motor and blower for the various pressures, to represent the various atmospheric pressures from Fort Collins down to sea level or lower, and maintain an atmospheric intake of 36 cubic feet of air per minute, the volume required at 5,000 feet for correct ventilation. Similarly the speeds were found for vacuum operation for the higher altitudes, except that here the discharge of the blower must be 36 cubic feet per

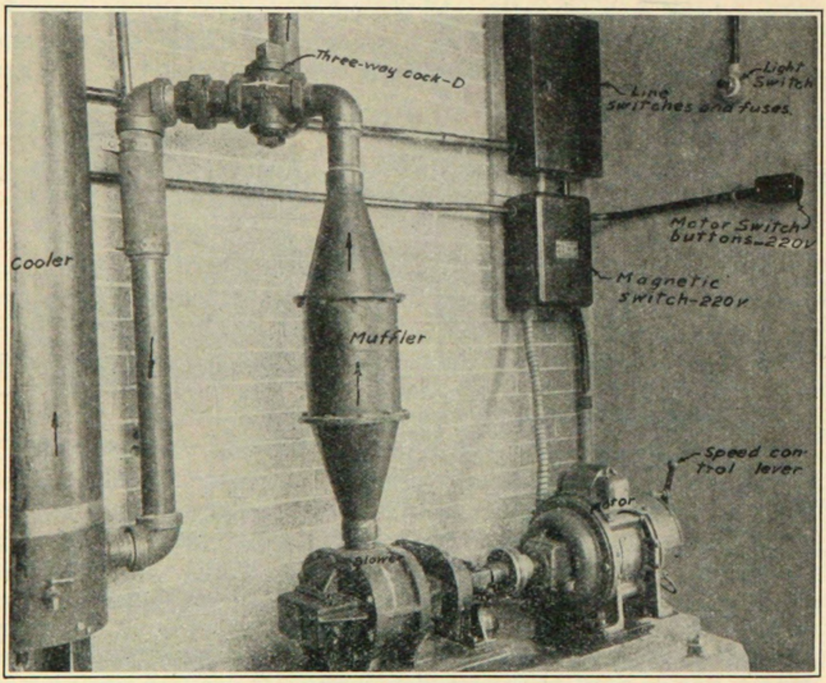

Fig. 3.—One corner of machinery room.

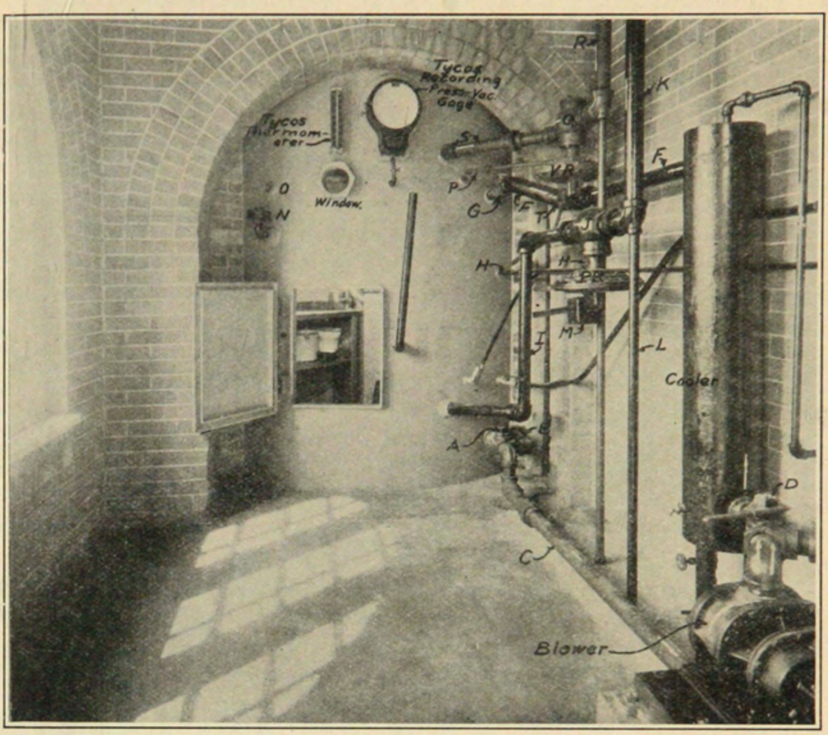

Fig. 4.—Machinery room.

minute to the atmosphere. By making a series of test runs at all pressures (and vacua or negative gage pressures), by half-pound steps, and using a tachometer or revolution counter, a record was made of the correct place on the brass scale in 32nds of an inch at which the motor-speed control lever and pointer should be set for each atmospheric pressure or altitude. Then when an experiment was to be made at say 2,500 feet altitude the operator would look at this speed table and read, say 21/32, and set the speed lever at that point.

This speed-control lever, however, is always set at or near zero to start the motor and is gradually moved up to the working position, in this illustration 21/32.

As the motor operates on 220 volts, it was considered desirable to use the magnetic switch shown. The motor is started and stopped by pushing one of two buttons on the 220-volt motor switch station, shown in Figure 3. A similar switch station was placed inside the altitude laboratory to enable the inside technician to stop the motor if such a need should arise. Three wires were run into the laboratory for the Edison three-wire lighting system. One 110-volt side is used for the electric oven and ceiling light. The other 110-volt side is used for the three units on the flat top part of the range. Two hundred and twenty volts are also available with this system if ever needed.

It will be noted that the muffler shown immediately above the blower in Figure 3 is not present in Figure 4. Two of these reclaimed Packard automobile mufflers were installed as an afterthought after the picture for Figure 4 was made. The two blower impellers are "tied" together by a pair of gears which give a slight humming noise much like the second speed gears in automobiles, but not so pronounced. To prevent this humming noise from being transmitted along a line of piping and other metallic equipment all the way from the blower to the steel tank altitude laboratory and there multiplied much like the sounds of a huge guitar or pipe organ, short pieces of fire hose were inserted at three points in the pipe lines. But the discharges of the air pockets from the blower impellers also make a light exhaust noise which could not be damped out by hose connections. At various certain speeds of the blower when the period of vibration was just right, huge, soft, beautiful, purring pipe-organ notes were broadcast all over the campus. However, some of the professors did not agree as to the beauty of these notes and scales and hence the early addition of the two mufflers at one dollar each. After this addition, all sounds were immediately eliminated, except the direct gear noise noticeable only when near the blower. One muffler was placed in the blower inlet line and the one shown in Figure 4 was placed in the blower discharge line.

The three-way cock shown above the muffler in Figure 3 can be set to send the blower-discharge air either straight thru and on down into the bottom of the cooler for pressure operation for lower altitudes, or it may be set to turn this air back into the pipe rising from the back of the cock and send it out thru the roof to the atmosphere when running on vacua for higher altitudes.

Referring now to Figure 4, this three-way cock appears lower down between the blower and the bottom of the cooler where the muffler was not yet installed. Here, too, the vacuum discharge line rising from the back of the cock and running thru the roof is cut off in the photograph, showing only a small part of the pipe elbow.

When running on pressure for sea level altitude, the air is compressed 2.42 pounds per square inch, giving a temperature rise of about 35 degrees F. when the atmospheric temperature is 60 degrees F. Hence, this air must be cooled before sending it into the altitude laboratory, especially during the summer months when the atmospheric temperature is often around 90 degrees F. The cooler was made by the Box Iron Works of Denver. It consists of a 10-inch pipe about 5 feet long with two upper heads and two lower heads. The two inner heads are connected by 32 copper tubes 3/8 inch in diameter. Water enters thru the small pipe at the top, fills the small space between the two upper heads, flows down thru the copper tubes into the small space between the two bottom heads and out thru a valve and pipe at the bottom to a sewer waste line. The inlet water line valve was placed inside the main building so it could be shut off in winter to prevent the apparatus from freezing. The compressed air from the blower enters the bottom of the cooler above the inner head, surrounds the copper tubes, rises to the top and passes on thru the 2-inch pipe into the altitude laboratory.

City water is used in the cooler. Its summer temperature varies from about 50 degrees to 60 degrees F. It cools the air very effectively, but there is still some temperature difficulty due to the direct sun heat striking the steel laboratory. A roof with celotex insulation was placed over the laboratory. An additional brick veneer and insulating wall may have to be added ultimately for summer comfort within.* For use during the hottest summer days an additional cracked ice cooler was built of galvanized iron and placed inside the laboratory. The entering air was passed thru a pipe into this cooler, caused to pass over the ice and out into the laboratory. During winter months the heating effect of compression is just about right to give a comfortable temperature within. The electric range, of course, gives off some heat, but the oven is very well insulated to keep the heat within. When running on vacuum, the heating effect of compressions is not encountered since the blower draws air away from the low-pressure altitude laboratory, compresses it up to atmospheric pressure and discharges it to the atmosphere, heat and all.

DETAILS OF OPERATION

In order that the reader may understand how the apparatus works as a whole, with all the above described units connected, it may be well to follow the air thru the complete cycle for both pressure and vacuum operation, stopping along the way to de-

*Note: Since the above was written a square inclosure of double thickness of celotex insulating sheets has been placed around the laboratory and a liberal packing of thermofil insulation included between the celotex and the steel shell. An elaborate system of electrical heating, refrigerating and humidifying of air is now being worked out for immediate installation.

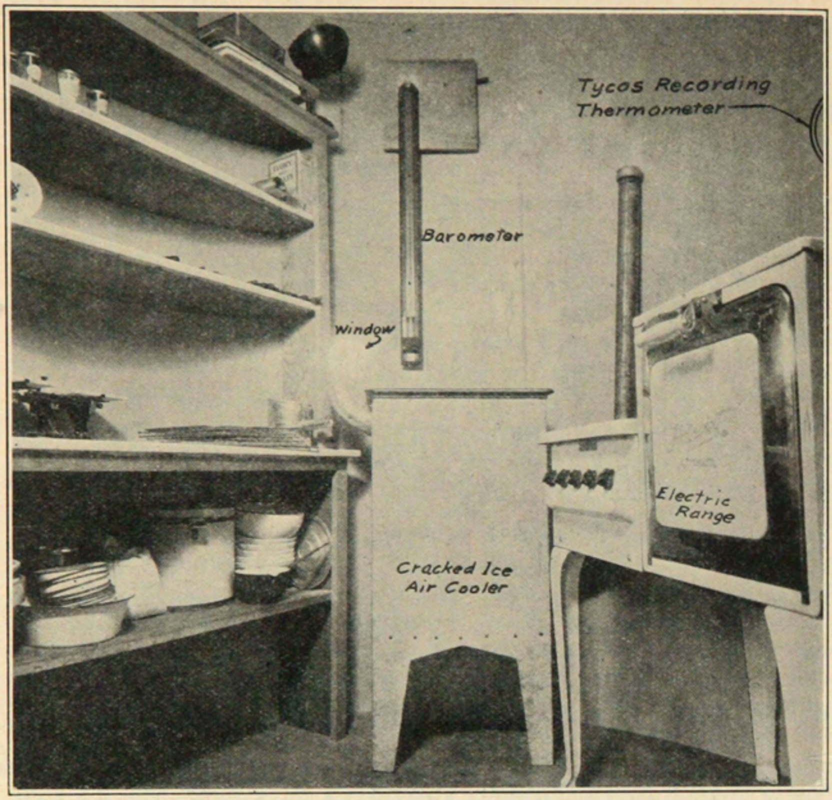

Fig. 5.—Interior view.

scribe a few pieces of equipment not yet mentioned. Figure 4 shows most of the equipment. The inside operator or technician steps into the altitude laboratory, closes the inner and outer doors and drops the inside door lever which also drops the outer lever. For pressure operation the outside machinery operator turns the three-way cock A at the lower right-hand corner of the room so that air will enter thru the pipe B leading in from the atmosphere thru the brick wall. She turns the three-way cock D on the outlet side of the blower so that the air will pass into the cooler. She opens the cooling water valve in the adjacent room and also the cooling water outlet valve. Now she turns on the electric motor which drives the blower, very gradually increasing the speed. The blower draws in air from the outdoor atmosphere thru pipe B, cock A and a muffler at C (not shown). The air passes up thru the blower, out thru cock D, thru the muffler (Figure 3) and enters the bottom of the cooler at E. It then rises thru the cooler and leaves at the top, thru the pipe F, passing on thru the check valve G into the altitude laboratory. It passes thru a pipe inside the room running under the range and up thru the cracked-ice cooler. The air pouring into the laboratory causes the pressure to rise. This increased pressure is communicated thru the small pipe H to the upper side of the diaphragm of the pressure regulator P.R. The diaphragm is forced downward, carrying with it a valve stem which opens the valve J above the diaphragm.

The air in the altitude laboratory now begins to flow out thru the pipe I, valve J and pipe K thru the roof to the atmosphere. Pipe L is merely a closed pipe leg standing on the floor to support the weight of the regulator. As the diaphragm moves down, the lower end of the valve stem pushes down on the end of a bar and lifts the weight M, there being a fulcrum pin between. The pressure in the laboratory at which the valve J begins to open is regulated by the position of the weight M on the bar. As M is moved farther out from the fulcrum more pressure is required to open the valve. M is moved out gradually by the operator until the pressure gage shown at the top center of the laboratory shows the correct pressure for the desired altitude.

A somewhat finer reading of pressure was obtained during the baking research work by use of a mercury U-tube inside the laboratory with one end connected thru a small pipe nipple to the outside atmosphere and the other end open to the inside. A high-grade aneroid barometer was also used to some extent.

Going back to the air flow, as fast as the air is driven in by the blower it passes out thru the regulator valve J. The flow is constant and not intermittent and thus the ventilation is maintained. The pressure cannot drop below the desired point, for if it should the valve J would close, due to the action of the weight M. If the pressure should tend to rise too high the valve J would open still wider, and maintain the correct pressure. Should anything ever happen to cause the pressure regulator P.R. to fail to function, especially if it failed to open, the pressure in the laboratory would go as high as the capacity of the blower, which is not dangerous to the inside operator, being only 5 or 6 pounds. But as an extra precaution the safety valve or pressure relief valve N was installed. The pressure at which it will pop off is regulated by the number of iron ring weights placed upon it. Directly above N at O but on the inside is placed another pop-off valve like N to act as a vacuum relief valve for safety when operating on vacuum. Should the vacuum become too great, due to possible failure of the vacuum regulator V.R., then the valve O would open and allow the atmospheric air, due to its greater pressure, to "pop in" and decrease the vacuum.

In order to stop the pressure run, the inside or outside operator presses the button to stop the motor and blower. The check valve G prevents back flow of the air from the altitude laboratory thru the blower. Such flow would do no particular harm, but it is not desirable to have machinery running backwards. The outside operator may now lift the weight M slightly, allowing the air slowly to flow out thru the valve J till the inside pressure drops to atmospheric. Or the inside operator may open a special hand-operated globe valve inside the room and let the pressure gradually drop to atmospheric. This latter method is better, since it is the inside operator whose ears may suffer if the pressure drop is too sudden or jerky. After the pressure is down, the doors may be opened and the pressure run has been completed.

To make the run on vacuum or on pressure lower than Fort Collins atmospheric pressure—for a higher altitude—the only mechanical change necessary is to turn the three-way cock A so that air may flow straight thru from the altitude laboratory to the blower, closing off the pipe B, and to turn the three-way cock D so that the discharge air from the blower may go out thru the pipe rising from D thru the roof instead of going to the cooler. A simple turn of cocks A and D is all that is required to change from pressure to vacuum. Now with the operator inside and the doors closed, the air is drawn from the altitude laboratory thru cock A, muffler C (not shown) into the bottom of the blower, out the top of the blower thru the muffler (Figure 3), thru cock D and out thru the roof to the atmosphere. As the air is drawn from the laboratory, the pressure within will drop or a relative vacuum will be produced. This reduced pressure or vacuum is communicated thru the small pipe P to the upper side of a diaphragm in the vacuum regulator V.R. This suction lifts the diaphragm upward, or more logically stated, the greater atmospheric pressure below the diaphragm pushes it upward. The diaphragm carries with it the valve stem which opens a valve at Q. Atmospheric air now rushes in thru the pipe R, valve Q and pipe S into the laboratory. Inside the laboratory this air is led across to the cracked-ice cooler and thence out into the laboratory. The weight T below the vacuum regulator is on the same side of the fulcrum pin as is the valve stem. Hence the weight holds the valve down and closed until the vacuum becomes great enough to lift the weight. The vacuum at which the valve Q begins to open is regulated by the position of the weight T upon the bar. This bar was bent downward so that as it lifts it will not strike the pipe F.

As fast as the air is drawn out of the laboratory by the blower, new fresh air rushes in from the atmosphere thru valve Q to take its place and maintain ventilation while the proper vacuum within is maintained by the vacuum regulator. The amount of vacuum is shown in inches of mecury by the recording pressure-vacuum gage shown in Figure 4. A check valve back of cock A prevents return flow of air thru the blower into the altitude laboratory after stopping the motor and blower, following a vacuum run.

The temperature within the altitude laboratory is indicated by a thermometer as shown in Figure 4. This thermometer has a horizontal, metal-covered bulb which projects thru the metal wall into the laboratory. The thermometer, the recording pressure-vacuum gage, a recording thermometer used on the oven and an aneroid barometer were loaned to the college by The Taylor Instrument Companies. The Hotpoint electric range was loaned by the Edison Electric Appliance Company, a subsidiary of General Electric Company.

PRELIMINARY EXPERIMENTS

In September of 1926 preliminary experiments were carried on to determine whether the insistant requests of housewives for help in cake-making at the higher altitudes were based upon serious problem difficulties.

The plan provided that three workers, immediately concerned with the altitude project, go together to three elevations where each worker would carry out the baking procedures definitely assigned to her.

The three locations chosen were Fort Collins at 5,015 feet, an Estes Park location at 7,700 feet and the shelter house at the summit of Fall River Pass at 11,797 feet. After completing experiments at these altitudes, a re-check was made at 5,015 feet.

The types of flour mixtures chosen were: Popovers, leavened by steam; angel and sponge cakes, leavened by the expansion of air, and butter cakes in which baking powder provided the leavening agent.

To one worker was assigned the preparation of the angel and sponge cakes; to the second, the making of a rich butter cake, and, to the third, the popovers, a simple butter cake and a false sponge cake. Such an assignment enabled each worker to develop more readily a definite technique, thus reducing the "personal equation" source of error.

The recipes chosen were those frequently used by housewives at 5,000 feet. (It was later found in experimental work that these same recipes might be improved by slight changes.)

A gasoline camp stove was used. The separate oven with glass door, and an inside dimension of 12 by 12 by 19 inches, was well insulated and gave even heat. A standard Taylor Instrument Companies' oven thermometer was used.

The same groups of utensils were used for all this work.

The ingredients, with the exception of milk, came from the same source of supply and all were weighed on a Harvard-Trip scale.

The results of these experiments are given in the following tables and show conclusively that the atmospheric pressure is a factor in the baking of flour mixtures.

POPOVERS

Flour......56.5 grams — Milk......106.7 grams
Salt......⅛ teaspoon — Egg...... 48 grams

Baking Temperature.—400° F. 15 minutes; 450° F. 15 minutes, 350° F. 10 minutes. Total time, 40 minutes.

Experiments	Altitude feet	Checks	Results
1	5,000	4	High, hollow, dry, very good.
2	11,797	2	Did not rise at all, heavy, soggy, looked like muffins.
3	7,700	2	Did not rise very much, moist and soggy, not hollow and dry, higher than 2.
4	5,000	1	Same as 1.

ANGEL-FOOD CAKE

Flour......110 grams — Egg-white......280 grams
Sugar......225 grams — Salt...... ¼ teaspoon
Cream of tartar...... ½ teaspoon

Baking Temperature.—250° F., 300° F., 350° F., 375° F., 15 minutes each. Total time, 1 hour.

Experiments	Altitude feet	Checks	Results
1	5,000	2	Good standard cake, light, high, tender.
2	11,797	2	Fell, complete failure, coarse, soggy, sticky.
3	7,700	1	Fell slightly in center. Moist, coarser and tougher than 1.
4	5,000	2	Same as 1.

SPONGE CAKE

Flour	112 grams	Salt	¼ teaspoon
Sugar	200 grams	Egg-white } Egg-yolk }	304 grams
Lemon juice	3 tablespoons		

Baking Temperature.—270° F., 300° F., 325° F., 350° F., 15 minutes each. Total time 1 hour.

Experi-ments	Altitude feet	Checks	Results
1	5,000	2	High, light, fluffy, tender, good standard cake.
2	11,797	1	Fell. Coarse, sticky and soggy.
3	7,700	1	High in back, fell in front, coarser than 1.
4	5,000	2	Same as 1.

Repeated 2, baking in wood range in the shelter house. The result was the same as with the gasoline oven.

EGG-YOLK SPONGE CAKE

Flour	150 grams	Egg-yolk	126 grams
Sugar	200 grams	Baking powder	8 grams
Salt	½ teaspoon	Water (boiling)	118.5 grams
Lemon juice	3 tablespoons		

Baking Temperature.—300° F. 20 minutes, 350° F. 25 minutes. Total time, 45 minutes.

Experi-ments	Altitude feet	Checks	Results
1	5,000	2	High, light and spongy, even, fine texture.
2	11,797	1	Fell. Time too short to finish baking. Sticky.
3	7,700	1	Fair, slightly too light and crumbly.
4	5,000	2	Same as 1.

PLAIN CAKE

Flour	304 grams	Fat	84 grams
Baking powder	18 grams	Milk	244 grams
Salt	½ teaspoon	Egg	96 grams
Sugar	260 grams		

Baking Temperature.—350° F. for 1 hour. Baked in tube loaf pan.

Experi-ments	Altitude feet	Checks	Results
1	5,000	3	Fair, reasonably fine grained, tender and light.
2	11,797	1	Fell completely, soggy, sugary, very coarse.
3	7,700	1	Not so bad as 2 but fell in center, coarse and sugary.
4	5,000	1	Similar to 1.

RICH CAKE

Flour	300 grams	Fat	112.5 grams
Baking powder	9.2 grams	Milk	122 grams
Salt	¼ teaspoon	Water	118.5 grams
Sugar	300 grams	Egg-white	150 grams

Baking Temperature.—350° F.

Experi-ments	Altitude feet	Checks	Results
1	5,000	4	Fine grained, quite light, tender.
2	11,797	1	Fell completely. Sugary, soggy, sticky.
3	7,700	1	Fell slightly in center. Coarse, heavy, layer on bottom.
4	5,000	2	Similar to 1.

In November of the same year one of the group of workers who helped to carry on the preliminary experiments just cited, was accorded the courtesy of laboratory privileges at the Bureau of Home Economics in Washington, D. C. There, over a period of 3 days, baking tests were made. Utensils, sugar, flour and baking powder were taken from Fort Collins. The recipes were those employed in preliminary experiments at 5,000 feet, 7,700 feet and 11,797 feet, and gave far better products than those obtained from the same recipe at the last two named elevations. The purpose in these preliminary experiments was to make sure that atmospheric pressure, as an influencing factor, warranted research on the scale anticipated by those in charge of the project.

SOME FACTORS INVOLVED IN MIXING AND BAKING FLOUR MIXTURES

INGREDIENTS

The ingredients most commonly used in flour mixtures are flour, sugar, leavening agents, fat, liquid, eggs, salt, chocolate, spices and flavorings. A knowledge of the chief characteristics of each is essential to the clear understanding of baking processes.

FLOUR.—Ostwald[7] defines flour as "a complex gelatinous powder consisting of proteins, starch and cellulose in the colloidal state. The individual particles contain molecularly dispersed salts, sugar, water and adsorbed gases such as air and carbon dioxide." This statement, as to the nature of flour is of value in understanding the physical and chemical changes taking place in the mixing and baking of flour mixtures.

Since flour is a mixture and not a chemical compound, the term is applied to any substance which has the same components, tho the amount of each component present may differ greatly in different flours and even in different runs of the same mill. The amount of certain of these components in a flour determines, to some extent, the characteristics of the flour and its value for baking purposes, altho there are other important factors as well.

The proteins[8, 9] are perhaps the most important of these components. Wheat flour owes its desirable properties to the nature of its proteins. It contains five kinds, but the principal ones are gliadin and glutenin. These two are present in the dough in a rather intimate physico-chemical mixture known as gluten. Whether the gluten is formed in the process of dough manipulation or exists in the endosperm of the wheat berry is an open question. This gluten absorbs water and forms an elastic gel which stretches under the tension of the carbon dioxide and raises the loaf.

The tenacity "with which gluten particle adheres to gluten particle" varies widely from flour to flour. Those flours which have a high ratio of carbon dioxide produced, to carbon dioxide diffusing thru the dough, are especially desirable for bread making and are known as strong flours. These produce very elastic, strong, gluten fibers. The flours with a low ratio of carbon dioxide produced to carbon dioxide diffusing thru the gluten are known as weak flours. The gluten strands of these flours are less elastic and more tender, thus these flours are more suitable for the making of pastries and cakes than for yeast breads. Recent work[10, 11] however, in several states has proved that bread may be successfully made from soft or weak flours if the proportion of the ingredients and the manipulation are modified.

The amount of gluten in a flour and its physical properties[9] are, in many instances at least, the determining factors as to whether or not a given flour will produce a satisfactory loaf. These physical properties are, in a large measure, determined at the time the proteins are laid down in the endosperm of the wheat berry, with the result that a strong flour is strong not because it differs in acid or salt content from a weak flour, but because its gluten is capable of forming a more tenacious gel than the gluten of the weak flour. Why the gluten differs in tenacity is unexplained but it is a fact. In an investigation as to which protein was responsible for the variation of the physical properties of the gluten it was found that the alcohol-soluble protein apparently showed uniform physico-chemical properties in both strong and weak flours but that the glutenin differed widely in these properties from flour to flour. From this evidence it was concluded that flour strength depends upon the physico-chemical properties of the glutenin and the proportion of it present in the gluten mixture.

Viscosity measurements[9] on flour-in-water suspensions, brought to a pH of 3.0 by the addition of lactic acid, have been found to serve admirably as a means of evaluating gluten quality. Since viscosity is an important property in emulsoid colloids it appears probable that the colloidal properties of the gluten gel are determining factors in flour strength. It is possible to destroy the desirable baking qualities of wheat flours by altering their physical properties.

The starch is another important component. For bread-making purposes the quality of the flour is influenced somewhat by the number and size of the starch grains[12]; the larger the number of small grains, the better the flour. Since the smaller the starch grains, the greater is the resistance to heat, moisture and chemicals, the resistance of the starch might be indicative of the influence of the starch on the baking strength of the flour.

The amount of moisture absorbed by flour also varies and is dependent to some extent on the amount of the other components present, such as the starch and the protein.

Flours from wheat may be classed under three heads, depending upon the type of wheat from which each is milled.[13]

1. Durum wheat yields a flour with a gluten content of 14 percent to 20 percent. This flour is called Semolina flour and is used for macaroni and similar pastes. It is seldom used in the home.
2. Hard, red, spring wheat produces flour with a gluten content of 10 percent to 14 percent. This is a strong flour and is used for bread, rolls, biscuits and light breads.
3. Soft, winter wheat yields a flour with a gluten content of 6 percent to 10 percent. It is known as weak flour and is used for cakes and pastries. Specially milled cake flour is a variety of this kind of flour.

With these facts in mind, it can readily be seen that *different kinds of flour cannot be used interchangeably in a recipe with identical results.* For the successful production of any product it is necessary to have a definite amount of each ingredient present and because of the variable composition of flour this would not be possible if another kind of flour should be substituted for the flour designated in the recipe. Especially is this true when flour is measured, because a cup of bread flour weighs approximately 113 grams while a cup of pastry flour weighs only about 100 grams. Thus in substituting bread flour for pastry, one would be adding a greater quantity of flour by weight. Even when the quantities are determined by weight one kind of flour cannot be substituted for another because of the difference in the quantity and quality of the gluten present. *Since all kinds of flour are available at a nominal price, the housewife desiring excellent results should choose the flour best suited to the product to be made.*

SUGAR.—This is obtained from two sources, sugar cane and sugar beets. It was formerly thought that the latter could not be so successfully used as the former, but this idea has been disproved. Beet sugar was used exclusively in all this work. Several grades of sugar, depending upon the degree of refinement, are available and each is especially adapted to certain kinds of bakery products.

Granulated sugar is more commonly used than any other. The only characteristic which may be found as a variable in this is the size of the crystals. In many products this is of no importance, but in the making of fine cake the smaller crystals give the finer texture. Coarse sugar may easily be made fine by rolling it on a board with a rolling pin.

Powdered sugar and confectioner's sugar are forms of granulated sugar that have been pulverized. Since these kinds of sugar are much finer than the granulated, they contain less moisture, and sometimes the commercial product contains a small amount of cornstarch to prevent the absorption of moisture by the sugar which would cause it to lump. Therefore, a product made with these kinds of sugar will have a finer texture but will be drier and more compact than a product made with granulated sugar.

Brown sugar is a form which has not been so thoroly refined as the white. It contains more moisture and therefore is especially well adapted for certain types of products.

Different kinds of sugar, like flour, *cannot be used interchangeably in a recipe with identical results*. However, they may be used interchangeably more successfully than flour if they are substituted according to weight instead of by measure.

LEAVENING AGENTS.—Bakery products are leavened, or made light, by three agents: Air, steam and carbon dioxide.

Air is incorporated into the batter or dough by various processes. It was stated in defining flour that the particles of the flour contained adsorbed air. This adsorption may be increased by sifting the flour several times, thus bringing the very fine particles in contact with the air. When the egg-whites or whole eggs are beaten they become foamy, showing that tiny bubbles of air have been caught and held. The same thing takes place when the batter is beaten with an under and over motion, so that the bubbles of air may be enclosed in the mass. When the batter is put into the oven to bake this air expands and helps to form the tiny air cells in the finished product.

Steam is formed during baking from the water in the batter. It is introduced into the batter in the flour, sugar, eggs and liquid. As the temperature is raised the steam is formed and in turn expands as does the air. When steam is used as the sole leavening agent, a high temperature is desired in order to coagulate the protein before the steam has all escaped.

Carbon dioxide is formed by the use of baking powder, the use of soda and cream of tartar and by the use of soda and some acid ingredients present in the batter.

Baking Powder.— Baking powder[14] is a mixture composed of baking soda, an acid ingredient and starch or some dry substance to act as a filler and to absorb moisture so that the powder will not react and lose its carbon dioxide prematurely. The soda, sodium bicarbonate, is the source of the carbon dioxide. The acid ingredient in the presence of water, will liberate the carbon dioxide from the baking soda. This acid may be an organic acid or an acid salt, as is shown in the tabulation to follow. Sometimes powdered egg albumin is also added.

There are various types of baking powder on the market and they are classified according to the acid ingredients which they contain. The use of these in baking is chiefly a matter of preference, tho they differ in the following characteristics[14] which must be kept in mind when making a choice.

Equal weights of all powders contain and liberate approximately equal quantities of carbon dioxide, but some act more rapidly in the cold than others. If a product is to be baked immediately, with only a slight amount of time consumed in the process of mixing, one of the rapid-acting powders gives excellent results. If, however, a longer time for mixing is desirable, and the product is to stand before being baked, a slower-acting powder gives better results. In using a baking powder one should consider the method in which it is to be used, for all powders give results that are very comparable if the manipulation and baking are suited to the powder and if the powder is used in the proper proportion.

The weights of equal volumes of the powders are not identical. Therefore, they cannot be used interchangeably by volume. The table of weights and measures will be of aid if one powder is to be substituted for another (see page 42).

The end products are different.[15]

The chemical reaction of a baking powder, regardless of the type, is

$NaHCO_3$	+	H—	=	Na——	+	H_2O	+	CO_2
Baking soda		acid		sodium salt		water		carbon dioxide

The chief points in regard to baking powders to be understood and borne in mind are given in the following tabulation:[14]

CARBON DIOXIDE LIBERATED FROM BAKING POWDERS HAVING ONE ACID-REACTING COMPONENT, WHEN TREATED WITH WATER AT 25 DEGREES C. (DR. J. R. CHITTICK)

Acid-Reacting Component	Total carbon dioxide. Percentage by weight.	Carbon dioxide liberated in 2 minutes by water. Percentage by weight.	Carbon dioxide liberated in 15 minutes by water. Percentage by weight.
Tartaric acid	14.0	13.8	14.0
Cream of tartar	14.0	10.6	13.8
Mono-calcium phosphate	14.0	8.6	9.3
Sodium aluminum sulphate	14.0	3.2	6.2

SUMMARY OF FACTS REGARDING BAKING POWDERS.

Type of baking powder	Acid component	Some well-known brands	Order of gas liberation in the cold	Soluble compounds formed which remain in the baked product
Tartrate	Cream of tartar* and tartaric acid	Royal Schilling	1	Potassium sodium tartrate and sodium tartrate
	Cream of tartar	Monarch	2	Potassium sodium tartrate
Phosphate	Mono-calcium phosphate	Rumford's Price's Farm House Yacht Club Red Front Webb's	3	Disodium phosphate
S. A. S. phosphate**	Mono-calcium phosphate and sodium aluminum sulphate	K. C. Calumet Davis O. K.	4	Sodium sulphate and some disodium phosphate

*The abbreviation "Tar." will often be used to designate a tartrate baking powder.
**The abbreviation S. A. S. refers to sodium aluminum sulphate.

Soda and Cream of Tartar.—Before the advent of the commercial baking powders the common practice was to use soda and cream of tartar. Many housewives still prefer this method of leavening. The essential reaction is the same as that given under baking powder.

Soda and an Acid Ingredient in the Batter.—In many varieties of baked products one of the ingredients contains an acid or has acid properties such as sour milk or sour cream, molasses and chocolate. In these cases the addition of the soda results in the evolution of carbon dioxide.

SHORTENING.—The housewife has a fairly large choice of shortenings and the one used is largely a matter of preference. Shortenings are divided into two classes: Those of animal origin, such as suet, lard, oleomargarine and butter; those of vegetable origin, such as nut margarines, cottonseed fat, and the oils of cottonseed, cocoanut, corn and olive. Shortenings differ in three main characteristics: Their fat content, their flavor and their physical state.

The shortening power of each of the above partially depends upon its actual fat content. Rendered suet, lard and the various oils are 100 percent fat, while butter and the margarines contain about 85 percent fat. Therefore, the latter have less shortening power per gram than the former. For successful substitution they must be used in equivalent amounts based upon their weight of actual fat.

The flavor of shortenings is quite pronounced and the choice of a fat should take this into consideration. Of course, butter has the best flavor when it is sweet and of a good grade. When another flavor is to predominate in a product, such as spice or chocolate, any shortening which is sweet and fresh may be used satisfactorily.

The physical state of the fat is important in some products. If the fat is to be added in the liquid state to a cold batter or liquid, an oil or a solid fat of low melting point is most desirable. In cakes, pies and biscuits a solid fat gives the better result and is chosen largely according to flavor.

LIQUID.—Here again there is a variety from which to choose. Milk is the most common. It adds to the flavor and food value of the baked product. It may be sweet or sour, condensed, evaporated or powdered. In each case the composition of the substance must be considered and adjustments made accordingly (see Table 66 for proportions of soda used with sour milk).

Cream, sweet or sour, is very satisfactory if the amount of shortening in the product is decreased according to the fat content of the cream.

Water may always be used but in less amount than the milk, since milk is only 87 percent water. The fat may then be slightly increased.

When substituting one liquid for another, the basis of substitution must be weight and percentage composition.

EGGS.—Fresh eggs are the most satisfactory, but cold storage or preserved eggs may be used if they are in good condition. Eggs do not beat well if too fresh. For angel and sponge cakes, eggs 2 or 3 days old are best. Cold storage and preserved eggs when beaten do not hold so much air as do fresh ones.

The two parts of the egg have different compositions. The white contains 12 percent protein, no carbohydrate and practically no fat. It is very viscous. The yolk contains 15 percent protein, 33 percent fat and no carbohydrate. Both contain water.

Eggs vary so greatly in size that to obtain identical results they must be weighed or carefully measured. Yolks and whites may be substituted for each other within certain limits on the basis of the percentage composition.

CHOCOLATE AND COCOA.—Chocolate is a product made from the cocoa bean and contains the rich cocoa butter and other desirable ingredients of the bean. Since it is rich in fat and contains carbohydrate, allowance must be made for these when chocolate is used in a recipe.

Cocoa is chocolate with part of the fat removed. A well-known brand has half the fat content of the chocolate. If used in place of chocolate, fat must be added. For use in angel and sponge cakes, cocoa is the more desirable. It also contains carbohydrate and, therefore, has thickening power.

FLAVORINGS.—Spices and flavorings may be used in many proportions and combinations according to the individual taste. In every case they should be of high grade because so much of the delicacy and pleasing flavor of the product is dependent upon them.

CHEMICAL FACTORS INVOLVED IN MIXING AND BAKING FLOUR MIXTURES

A brief survey of the factors which have been found to influence the final loaf, in bread making, suggests the magnitude and complexity of the problems that confront chemists in their study of factors involved in the preparation of quick breads and cakes.

The making of bread is no longer a haphazard affair, but a scientifically controlled process. The many variable factors, such as mineral content of water, gluten content of the flour, acidity, temperature and humidity, must be controlled in order to produce a uniform product.

During the last few years more and more attention has been centered on the colloidal properties of flour and dough, the physical and chemical changes taking place and the importance of the acidity, with its relation to the growth and activity of the yeast.[15]

Some of the findings in this intensive study of the bread problem may be applied in the investigations to be undertaken in connection with quick breads and cakes.

In order to understand the nature of the colloidal properties it is essential to know what is meant by a colloidal solution and its chief characteristics. When a finely powdered solid substance is placed in a liquid and stirred vigorously one of three things takes place: (1) The substance dissolves. By this is meant that it becomes molecularly subdivided and distributed homogeneously thruout the liquid, remaining this way indefinitely. (2) It forms a colloidal solution. In this case the particles are very small but are not molecularly subdivided. They are, however, homogeneously dispersed thruout the liquid, and do not settle out on standing. (3) It merely forms a temporary suspension and settles out or forms a layer on the bottom of the container.

Thus the size of the particles of a colloidal solution are intermediate between the molecules of the true solution and the larger aggregate particles of a suspension. Homogeneous dispersion and absence of settling are characteristics of a colloidal solution.

Solutions, however, are not necessarily mixtures of solids in liquids. Any combination of the three forms of matter are possible, such as a gas in a gas, a gas in a liquid, a liquid in a solid, etc. The substance which forms the larger percentage of the solution is called the solvent and the other substance the solute. In a colloidal solution the former is termed the disperse medium and the latter the dispersed phase.

A classification[16] of disperse systems with reference to the contact surface may be given as follows:

1. Contact surface. Gas-liquid.
   - (a) A liquid dispersed in a gas. Examples: Mist, fog, clouds, spray.
   - (b) A gas dispersed in a liquid. Examples: Foam, suds and lather.
2. Contact surface. Gas-solid.
   - (a) Fine particles dispersed in a gas. Examples: Smoke, dust, fumes.
   - (b) A gas dispersed in a solid. Example: Certain solid foams.
3. Contact surface. Liquid-liquid.
   Examples: Emulsion of one liquid in another. Milk is an emulsion of fats in water. Mayonnaise is an emulsion of fat in water.
4. Contact surface. Crystal-liquid. Crystals dispersed in a liquid.
   Examples: The large number of colloidal solutions and suspensions familiar to the chemist.

Flour and dough have been considered as colloids, as has already been stated, and exhibit the characteristic properties of such. When flour is sifted repeatedly the amount of dispersed air is increased. The beating of egg-whites or whole eggs forms a foam which is a gas-liquid colloid. The egg-white alone forms a more stable foam than when the yolk is present.

As shown above, an emulsion is formed when a liquid is dispersed in a liquid. The ones most commonly known are of oil and water. Milk is an example of fat in water and butter an example of water in fat. The stability of the emulsion depends upon the interfacial tension between the two liquids. If this is low the emulsion will be stable. Some substances, when added to a mixture of two liquids produce this condition of low interfacial tension and increase the amount of the one liquid which may be dispersed in the other. Such substances are called emulsifiers. Egg albumin falls in this class and makes it possible to emulsify oil or fat in water as in the case of mayonnaise dressing. Soap is another substance often used to effect emulsification.

Ideas in colloidal chemistry[17] are organized around the individual particle as a center. Flour and dough are considered as colloids and exhibit the characteristic property of such. When flour is sifted repeatedly the amount of dispersed air is increased. Dough is a mass of protein and starch particles which have absorbed water and which are covered with thin films of water. Surface-tension forces hold these particles together. Upon these forces are based the colloidal properties of the dough and also the assumption that the protein particles adhere and form chains or strands with a rubbery elasticity, which are matted together and are known as gluten, and in which are imbedded the starch particles. The environment of the particles, which is chiefly water in which are dissolved substances, is important and effects the electrical condition and thus the binding force among the particles.

Intimately mixed with the gluten and starch in the solution are the sugar, egg and fat. All these substances except the fat are either soluble in water or miscible with it. As mixing continues the protein strands are constantly being brought together and adhere, then stretched to meet other strands, thus building up the network of structure of the product. These strands and starch grains are thus soaked in the solution of sugar and chemical leavening agents and mixed with the egg-fat emulsion. The fat is very homogeneously mixed with the other ingredients but not dissolved. Experimental evidence, in work on cookies[18] has shown that where no egg is present the fat spreads over the fresh surfaces of the gluten strands and coats them with grease so that they do not adhere so firmly together as they would do if the fat were not present. It may be inferred that a somewhat similar reaction takes place when the egg is present and the fat is emulsified and spread evenly thruout the batter. This would account for the relation existing between the tenderness of a texture and the fat content.

During the process of mixing, gas bubbles are formed thruout the batter from the air which is being incorporated and from the action of the leavening agents in the presence of water. Except in the case of muffins, experimental evidence has shown that the most satisfactory bakery products are produced from batters and doughs in which the ingredients are most thoroly mixed, that is, as the batter approaches and becomes a colloidal solution.

In baking, many changes[18] take place. The sugar solution, starch and gluten become very soft and plastic. The air, steam and carbon dioxide expand and raise the mass, making it resemble a sponge with very tiny cells. As these cells are formed, the increased surface causes increased evaporation and the sugar solution becomes very concentrated, approaching the condition of hard-boiled candy. If there were no shortening present this concentrated sirup, on cooling, would become a hard, continuous mass of material, in which would be imbedded partially ruptured starch grains and the network of coagulated gluten. The fat, however, breaks this up and makes it possible to separate the particles, thus giving to the product the property referred to as tenderness. The starch cells are somewhat broken so that they become more digestible. The crust is chiefly dextrin and carmelized sugar, which helps to prevent the escape of the gases within the loaf, making the product light.

EQUIPMENT AND UTENSILS

OVENS.—Three types of ovens were used in the experimental work. A portable one, described on page 26, was used on field trips in making confirmatory tests. The oven of a Pennsylvania gas stove was used for all work in the chemical laboratory. This oven was equipped with a glass door, and tho it had no regulator, its temperature could be fairly well controlled. In the altitude laboratory, the oven was a Hotpoint Electric equipped with a thermostatic regulator. There was also placed in this oven the bulb of a Tycos Mercury-Actuated Capillary-Form Recording Thermometer which gave a chart of the temperature at all times. In all three ovens the kitchen Tycos oven thermometers were used, and these were tested often for accuracy.

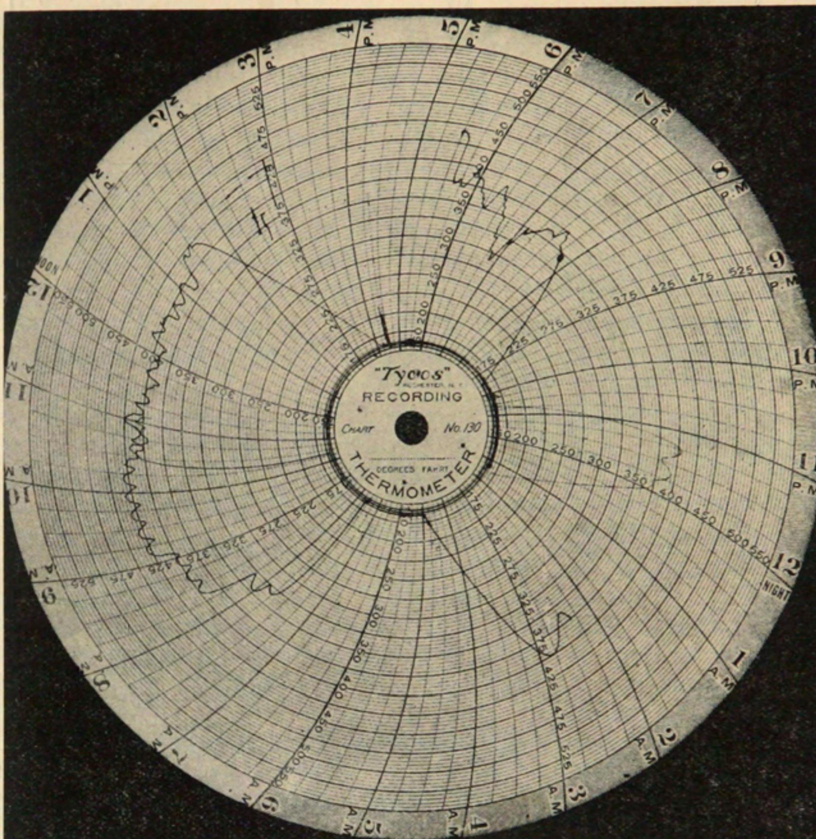

Fig. 6.—A typical Tycos baking-temperature chart.

SCALES AND WEIGHTS.—A Harvard-Trip Scale, sensitive to 0.1 gram, and a set of weights from 1 gram to 1 kilogram standardized against United States Bureau of Standard Weights were used. Weighings were made within 0.1 gram and every precaution taken to remove the material completely from the bowls, so that any error due to weight would be negligible.

UTENSILS.—Porcelain bowls with sloping sides were used. Three sizes were found to be efficient: A 1-quart size for popovers, for small proportions of biscuits, and in which to sift flour for cake; the 2-quart size for muffins, biscuits, and for a half-recipe of a cake; the 3-quart size for mixing either a whole or a half-recipe of a cake; a 2-gallon milk crock for angel and sponge cakes. Enamel bowls of 1-pint capacity were used as receptacles for ingredients.

The advantage of having utensils to fit the work cannot be over-emphasized. A bowl of the wrong size is unhandy and unwieldy. Porcelain was chosen because of a desirable weight and shape. Glass is also satisfactory. Enamel bowls are not so good in shape, tip easily, and are easily scratched and chipped.

Wooden mixing spoons were selected because they do not discolor the materials and they are much more easily handled than are metal spoons. A solid spoon is superior to a slotted one because it gives a smoother mixture in less time, less waste of material, and it is easier to clean.

The egg beater used was made of aluminum. It had a well-shaped handle, was easy to grasp, and was so well geared that the action was very efficient.

Three spatulas, all with very flexible blades, were used. A small one with a blade ¾ inch wide and 3½ inches long; a medium one, 1 inch wide and 5 inches long, and a large one 1½ inches wide and 8 inches long. These made it possible to remove material completely from any sized bowl.

Experience demonstrated the desirability of using two brushes. A 2-inch brush was used for removing dry materials from bowls or papers and a 1-inch brush for oiling all pans and cups for baking. Varnish brushes were found to be more satisfactory than regular pastry brushes because of their size, shape, softness and quality.

The usual glass measuring cups, measuring spoons and flour sifter were used.

One set of baking utensils was used thruout each of the experiments; for popovers a set of three earthenware cups; for muffins and cup cakes, two sets of six of the tin muffin pans with an upper diameter of 3 inches; for the angel and sponge cake and the large loaf cake, square tube pans of tin 8 inches square and 3½ inches deep; for layer cake and biscuits, tin pans with solid bottom 8x8x1¾ inches.

MEASUREMENT, MANIPULATION OF INGREDIENTS AND BAKING

MEASUREMENT.—Laboratory accuracy is gradually finding its way into the American home. Instead of the old-time tea and coffee cup, the housewife has access to graduated measuring cups of glass and aluminum, to measuring spoons, oven thermometers and thermo-regulated ovens.

However, there still remain difficulties[14] in obtaining identical quantities of ingredients. There are two ways of determining quantities, by weighing and by measuring. The former is by far the more accurate, for with a little practice weights may be duplicated within a gram. Some sources of error in measuring are these: Measuring cups vary; sections of measuring cups are not accurate; no person measures any food ingredient in exactly the same way every time; no two persons measure just alike; the state of the material, especially of shortening, affects the measurement.

Weighing is a common practice in Europe, but in America the majority of housewives still measure. If all would weigh in grams, results would be more uniform.

The following directions should be observed[14]:

Flour.—Sift a small amount once, then sift into the cup, and level with the edge of a spatula. This gives a quantity nearest to the accepted weight.

Baking Powder.—Heap the measuring spoon by lifting it up lightly thru the powder, then level with the edge of a spatula.

Granulated Sugar.—Sift into the cup and level with spatula.

Confectionery Sugar.—Roll, sift once, then sift into the cup and level with spatula.

Brown Sugar.—There is no very satisfactory method. Roll, if there are lumps, and pack solid into the cup.

Liquids.—Fill the cup or spoon *full,* empty *completely.*

Fats.—Avoid air spaces in cold fat. Room temperature is best. Pack very solidly into the measuring utensil, then level off. Measure small amounts in a tablespoon.

Eggs.—Beat until a homogeneous mixture is obtained. Let stand until the foam disappears. Measure as for liquids.

At best the weights for 1 cupful of various food materials can be approximated only. There are, however, some more or less accepted standards of which three sets are given: The first by Sybil Woodruff[19]; the second by Halliday and Noble[14]; and the third a set adopted for these experiments.

TABLE 1.—MEASURES AND WEIGHTS OF FOOD MATERIALS.

Food material	Measure	I grams	II grams	III grams
Baking powder				
Tartrate	1 teaspoon	3.07	3.84	3.85
Phosphate	1 teaspoon	3.07-3.52	4.00	4.00
S. A. S.	1 teaspoon	....	4.00	4.00
Flour				
Pastry	1 cup	100	96	100
Family	1 cup	113	113	113
Sugar				
Granulated	1 cup	200	200	200
Brown light	1 cup	135	....	....
dark	1 cup	140	....	....
loose pack	1 cup	....	....	....
solid pack	1 cup	....	200 approx.	200 approx.
Powdered	1 cup	104	100 approx.	100 approx.
Butter	1 cup	225	210	225
Crisco	1 cup	200	200	200
Snowdrift	1 cup	200	180	200
Milk	1 cup	244	244	244
Egg 1 medium sized	....	48.6	48.0	48.0
1 yolk	....	17.4	18.0	18.0
1 white	....	30.4	30.0	30.0
Cream—18 percent	1 cup	240	239	240

The only weight which varies more than a few grams is butter. The weight given by Woodruff was chosen for the following reason. A commonly accepted standard among housewives is that there are two cups of butter to a pound. Since a pound equals 453.59 grams, this would make a cup of butter weigh 226.8 grams. In this laboratory it was found that the tablespoon of butter averaged 14 grams, which would be the calculated value.

In these experiments the aim has been to standardize baking procedure. It was found that when recipes were duplicated, the results were also always duplicated. Each experiment was carried thru a sufficient number of times to insure against accidental results and it is believed that if the weights, manipulations and baking temperatures are accurately followed, corresponding results will be obtained by other experimenters.

All food materials were weighed just before using. The following general method was adopted because it gave the most accurate results in the least time. The scales were tested and adjusted for accuracy. At the beginning of each experiment an enamel bowl with a liquid capacity of 1 pint was selected to hold the material to be weighed and placed on the left-hand plate of the scale. A small tin can with cover was placed on the right-hand plate. The small adjustable thumbscrews below the right-hand plate were placed in the center of the bar, then millet seed was added to the can until perfect adjustment was obtained. The cover was placed on the can and this enamel bowl and can used always for weighing. In this way the amount of change of weight of the enamel bowl from time to time was so slight that perfect balance could be obtained by adjustment of the thumbscrews.

The process of weighing, of course, varied with each product, but the following order was observed. After adjustment of the empty bowl, the weights, equal to the required amount of baking powder, were placed on the right-hand plate and baking powder added to the bowl to balance. Without removing either baking powder or weights, the weights equal to the required amount of flour were added to the right-hand plate and the flour weighed out into the bowl. Since the amount of the baking powder is so small in comparison to the quantity of flour, the flour may be added without in any way altering the amount of the baking powder. This mixture was placed in the sifter, which had been set in a bowl, and all the flour removed from the enamel bowl by brushing the inner surface gently with the dry pastry brush and tapping the brush on the wires of the sifter to dislodge any particles adhering to it.

The enamel bowl was returned to the scale plate and the reading observed to be sure that it had not changed in weight. The sugar was then weighed in a similar manner and placed in a small enamel bowl. Any other dry ingredients were weighed at this time.

The next ingredient, the shortening, was carefully placed in the bowl and weighed, then transferred to the mixing bowl, removal from the enamel bowl being effected by means of a very flexible spatula. In the case of solid fat the removal was practically complete and a careful use of the spatula around the sides of the bowl removed almost all the melted fat. The enamel bowl was returned to the scale plate and balance obtained by adjustment of the thumbscrew, or, if the difference was too great, by the use of the rider.

The required amount of milk was weighed and placed in another bowl, again removing as much as possible of the liquid with a spatula. This time when the enamel bowl was returned to the scale plate, adjustment was always necessary by means of the rider, but the amount was only a few tenths of a gram.

The egg mixture which had been beaten enough to form a homogeneous mass and allowed to stand until the foam had disappeared, was weighed last and allowed to remain in the same bowl. Repeated experiments showed that the amount of this mixture adhering to the bowl and egg beater was approximately 1 gram. For this reason, the amount of egg mixture weighed out was 1 gram more than the required amount. When eggs were separated and weighed thus, the bowl was cleansed after all the other ingredients had been weighed, and the egg-white weighed first, or the egg-white was weighed before the shortening, and then the egg-yolk weighed.

MANIPULATION OF INGREDIENTS.—Since the manipulation varies so greatly with each type of flour mixture, it is thought best to give it in detail in the discussion of each product.

BAKING TEMPERATURE

One of the most important factors in the baking of flour mixtures is the temperature of the oven. This temperature varies in different parts of the oven. The rack was placed 3 inches above the bottom of the oven and the thermometer set on this rack midway from front to back and as close to the edge of the baking pan as possible. The baking pan was placed in the center of the rack.

The definite temperatures used are discussed under each type of product.

CLASSIFICATION OF FLOUR MIXTURES

There are so many types of flour mixtures that a classification is helpful. This may be determined by any one of several factors: The consistency of the batter; the richness of the batter; the leavening agent. Since the leavening agent is a factor common to every flour mixture and of great importance, this was chosen as the basis for classification.

There are three leavening agents employed in baking: Steam, air and carbon dioxide.

The following tabulation gives the classification employed:

LEAVENING AGENT	FLOUR MIXTURE
Steam	Popovers
	Cream puffs
Air	Sponge cakes
	White—Angel food
	Yellow—Sponge cakes
	True
	False
Carbon dioxide	
Source—soda and acid	Baking-powder biscuits
	Muffins
	Butter cakes
Source—yeast	Bread and rolls

All of the above flour mixtures were studied and are herewith reported on with the exception of yeast bread and rolls.

EXPERIMENTS AND RESULTS

FLOUR MIXTURES LEAVENED BY THE EXPANSION OF STEAM—POPOVERS

Of the first group of flour mixtures, popovers have been chosen for study. This type of quick-bread is high, irregularly shaped and has a rich brown, tender, crisp crust. The inside is almost completely hollow, with perhaps a small membrane of material across the center. The batter consists of almost equal proportions of flour and milk with the addition of egg and a small amount of fat.

The variations in the proportions of ingredients in various recipes are surprising when one considers the simplicity of the batter. The following tabulation gives the range of variation found by comparing recipes from well-known sources. The top figures represent the minimum, and the lower the maximum values.

RANGE IN PROPORTIONS OF INGREDIENTS QUOTED IN POPOVER RECIPES

	Flour cup	Salt teaspoon	Fat tablespoon	Milk cup	Egg	Baking temperature °F.	Time minutes
Minimum..	1	⅛	....	⅘	1	Slow, 350	30
Maximum	1	¼	1	1	3	Very hot, 475	45

The instructions given for mixing popovers differ but slightly. In most cases the liquids, beaten egg and milk, were combined and added slowly to the sifted dry ingredients, flour and salt; the melted fat was added and the whole beaten just enough to produce a smooth batter. The variations to this general method were to separate the eggs, adding the whites last; and to beat for 5 minutes. These variations seem to be based upon the idea that incorporated air is the leavening agent, which idea is erroneous.

A series of experiments conducted for The American Stove Company[20] under the direction of Miss Dorothy E. Shank showed that the first method given was the most satisfactory and this was the method used in the series of experiments to follow. The hot cups were removed from the oven, oiled quickly, filled half full of the batter, and returned to the oven to bake.

There seemed to be a difference of opinion as to the temperature and time of baking required to produce the best results. Those given were: Bake in a slow oven until done; place in a quick or very hot oven until done; place in a hot oven, then later reduce the temperature. Under the last method the range of temperatures advocated is very considerable, running from 350 degrees F. to 475 degrees F. for the first period, and from 325 degrees F. to 350 degrees F. for the last period. The time required varies from 30 to 45 minutes.

This variation, no doubt, is dependent upon three factors: The kind of material of which the baking pans are made; the quantity of batter in each pan; the amount of heat present in the pan when the batter is added.

The above-mentioned work on popovers[20] demonstrated that the best results were obtained when baking dishes were used which held the heat, such as iron, glass and earthenware. For baking, the most satisfactory results were obtained when the cups were preheated for 10 minutes in a 450 degree F. oven, then oiled and filled quickly with the batter, and returned to the oven. The temperature of the oven was allowed to remain at 450 degrees F. for 30 minutes, then reduced to 350 degrees F. for 15 minutes. This procedure was followed in the three groups of experiments reported herewith.

PROCEDURE AND RESULTS

UTENSILS.—The utensils used included scales, weights, 1-quart mixing bowl, three enamel bowls, flour sifter, egg beater, mixing spoon, measuring spoons, spatula, brushes for flour and for fat, earthenware cups and oven thermometer.

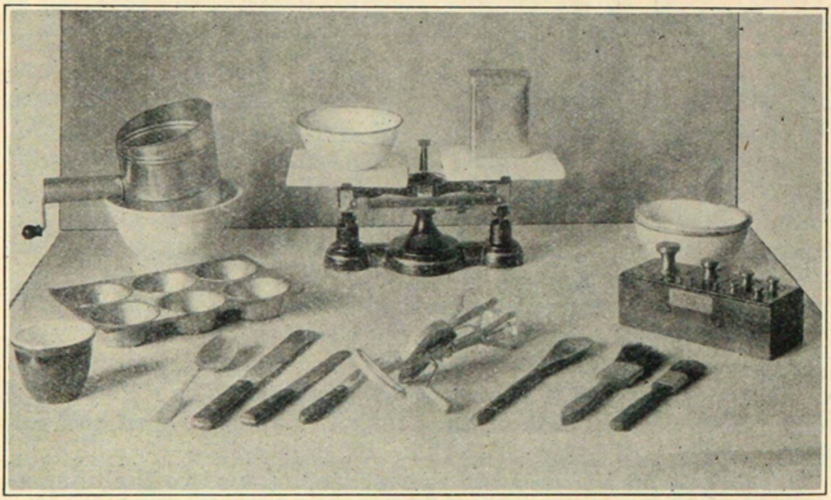

Fig. 7.—Utensils used for popovers and muffins.

INGREDIENTS.—The ingredients employed consisted of bread flour, salt, eggs, sweet milk and butter.

MEASUREMENT, MANIPULATION OF INGREDIENTS AND BAKING.—After all utensils and ingredients had been assembled, the baking cups were placed in the heated oven on a sheet of tin, which facilitated their handling.

The egg was beaten just enough to form a homogeneous mixture but with as little foam as possible, this in preparation for exact measuring.

All measuring was carried on as outlined on pages 40 to 44.

The dry ingredients were sifted into the mixing bowl, the liquids slowly added, beating constantly to prevent the formation of lumps and to give a smooth batter. The melted butter was then added. The cups, preheated at 450 degrees F. for 10 minutes, were then quickly brushed with fat, filled half full of the mixture and quickly returned to the oven to bake. The temperature of the oven was allowed to remain at 450 degrees F. for 30 minutes, then the heat reduced to 350 degrees F. for the last 15 minutes of baking.

TABLE 2.—POPOVERS.

Variations in Proportions of Ingredients at Sea Level. Atmospheric Pressure, 29.9 Inches of Mercury.

Experiment	Flour grams	Salt teaspoon	Egg grams	Milk grams	Fat grams	Checks	Results
1	56.5	1/8	48	122.0	7	4	High, hollow, crisp, dry, very good.
2	56.5	1/8	48	114.3	7	2	High, hollow, crisp, drier than 1, good.
3	56.5	1/8	48	106.5	7	2	Not quite so high and hollow as in 1 and 2.
4	56.5	1/8	48	122.0	....	2	Similar to 1 but not so tender or so good in taste as 1.
5	56.5	1/8	24	122.0	7	5	Moist, more like a muffin, not high, hollow and crisp.

TABLE 3.—POPOVERS.

Variations in Proportions of Ingredients at 5,000 Feet. Atmospheric Pressure, 24.9 Inches of Mercury.

Experiment	Flour grams	Salt teaspoon	Egg grams	Milk grams	Fat grams	Checks	Results
1	56.5	1/8	48	122.0	7	3	High, hollow, good color, tender crust.
2	56.5	1/8	48	114.3	7	3	Not quite so high and hollow as 1, crisp crust.
3	56.5	1/8	48	106.5	7	5	Not so high as 1 but dry, crisp, very good.
4	56.5	1/8	48	106.5	....	4	Slightly higher and hollow, but not so brown and crisp as 3.
5	56.5	1/8	24	122.0	7	4	Small, compact, muffin like, did not rise.

In the two groups of experiments given above the smaller amount of egg was found to be unsatisfactory. Miss Shank reports satisfactory popovers using 1 egg to 1 cup of flour, but the amount of batter in each iron pan was 1½ tablespoons, while in the above experiments each cup held approximately 3. This might account for the difference in results, since there would be less batter to be raised by the steam formed during baking.

The following experiments give results obtained by using smaller cups and placing just 1½ tablespoons of batter into each.

TABLE 4.—POPOVERS.

Comparison of Sea-Level Formulas Differing in the Amounts of Egg. Atmospheric Pressure, 29.9 Inches of Mercury.

Experiment	Flour grams	Salt teaspoon	Milk grams	Egg grams	Fat grams	Checks	Results
1 Recipe I	56.5	⅛	122	24	14	5	Small and muffin like slightly hollow, fair crust, dry inside.
2 Recipe II	56.5	⅛	122	48	14	3	Popover shape, quite good size, hollow and dry, crisp crust.

It was not discovered what made the difference, but at no time was it possible to make satisfactory popovers from Recipe 1.

TABLE 5.—POPOVERS.

Variations in Proportions of Ingredients at 11,180 Feet. Atmospheric Pressure, 19.9 Inches of Mercury.

Experiment	Flour grams	Salt teaspoon	Egg grams	Milk grams	Fat grams	Checks	Results
1	56.5	⅛	72	152.5	....	2	Very high, hollow, good shape, slightly moist.
2	56.5	⅛	72	137.3	7.0	2	Not so high and hollow as 3.
3	56.5	⅛	72	137.5	....	2	Very satisfactory, drier than 1.
4	56.5	⅛	72	122.0	....	2	Not so high and dry as 3 and 5.
5	56.5	⅛	72	122.0	....	2	Very much better than 4 but not so good as 3. Quite satisfactory however.
6	56.5	⅛	48	137.5	7.0	2	Quite muffin like, slightly higher than 7
7	56.5	⅛	48	122.0	7.0	3	Did not rise at all.
8	56.5	⅛	48	114.8	7.0	2	Did not rise at all.
9	56.5	⅛	48	137.3	3.5	2	Rose slightly above edge of cup, more hollow than 6.
10	56.5	⅛	48	122.0	3.5	3	Slightly better than 7, not so high as 9.
11	56.5	⅛	48	152.5	....	2	Best of Experiments 6 to 13.
12	56.5	⅛	48	122.0	....	2	Not so high and hollow as 11.
13	56.5	⅛	48	91.5	....	2	Did not rise at all. Hard.
14	56.5	⅛	24	122.0	....	2	Small and solid, hard, did not rise at all.

TABLE 6.—POPOVERS.

Summary of Results Presented in Tables 2, 3 and 5. The Optimum Proportions of Ingredients at Sea Level, at 5,000 Feet and at 11,180 Feet.

Ingredients	Sea Level (29.9 inches) grams	5,000 Feet (24.9 inches) grams	11,180 Feet (19.9 inches) grams
Flour	113 *(1 c.)	113 (1 c.)	113 (1 c.)
Salt	(¼ t.)	(¼ t.)	(¼ t.)
Milk	214-244 (⅞-1 c.)	244 (1 c.)	244-275 (1-1⅛ c.)
Egg	96 (2 eggs)	96 (2 eggs)	144 (3 eggs)
Fat	14 (1 T.)	7 (½ T.)	....

*The abbreviations used in this bulletin are: t., teaspoon; T., tablespoon, and c., cup.

A summary giving the modifications for the entire range of atmospheric pressures follows:

TABLE 7.—POPOVERS.

Proportions of Ingredients for the Range in Altitudes Between Sea Level and 15,500 Feet.

Atmospheric pressure inches**	Altitude feet	Flour grams	Salt teaspoons	Milk grams	Egg grams	Fat grams
29.9	Sea level	113 1 c.*	¼	213.6 14 T.	96 2 eggs	14.0 1 T.
28.9	1,018	113 1 c.	¼	219.6 14 T. + 1¼ t.	96 2 eggs	14.0 1 T.
27.9	1,977	113 1 c.	¼	225.7 14 T. + 2½ t.	96 2 eggs	11.7 2½ t.
26.9	3,000	113 1 c.	¼	231.8 15 T. + ¾ t.	96 2 eggs	11.7 2½ t.
25.9	4,004	113 1 c.	¼	237.9 15 T. + 2 t.	96 2 eggs	7.0 1½ t.
24.9	5,000	113 1 c.	¼	244.0 1 c.	96 2 eggs	7.0 1½ t.
23.9	6,200	113 1 c.	¼	250.1 1 c. + 1½ t.	96 2 eggs	7.0 1½ t.
22.9	7,360	113 1 c.	¼	256.2 1 c. + 2½ t.	96 2 eggs	4.7 1 t.
21.9	8,500	113 1 c.	¼	262.3 1 c. + 1⅓ T.	96 2 eggs	4.7 1 t.
20.9	9,820	113 1 c.	¼	268.4 1 c. + 1⅔ T.	144 3 eggs	....
19.9	11,180	113 1 c.	¼	274.5 1 c. + 2 T.	144 3 eggs	....
18.9	12,500	113 1 c.	¼	280.6 1 c. + 2⅓ T.	144 3 eggs	... .
17.9	14,000	113 1 c.	¼	286.7 1 c. + 2⅔ T.	144 3 eggs	....
16.9	15,500	113 1 c.	¼	292.8 1 c. + 3 T.	144 3 eggs	....

*For abbreviations used in this table see footnote of Table 6.

**Inches of mercury.

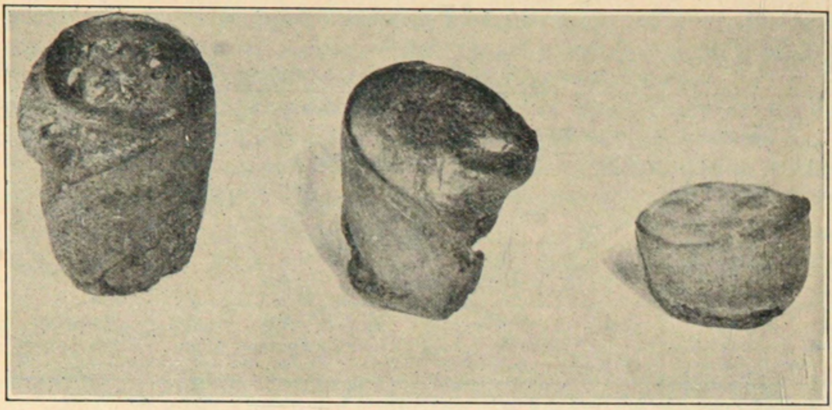

Fig. 8.—Popovers at sea level, at 5,000 feet and at 11,180 feet, using the same recipe at the three altitudes.

A change in atmospheric pressure has a greater influence on the baking of this type of flour mixture than on several of the more complex ones. The illustrations given above show the differences found. Each of the popovers shown was made from the same recipe with equal weights of ingredients and with the same manipulation, temperature and time of baking. The first, made and baked at an atmospheric pressure of 29.9 inches of mercury (sea level), was high and hollow with a dry inner lining and a crisp, brown crust. The second, baked at an atmospheric pressure of 24.9 inches of mercury (5,000 feet), was not so high or dry as the first; while the third, baked at an atmospheric pressure of 19.9 inches of mercury (11,180 feet), was nearer like a muffin, having failed to rise. This one had a moist, almost doughy center. The crust was not so crisp in the second and third as in the first.

When the atmospheric pressure is reduced the escape of steam is greatly facilitated by the lower point of evaporation. Thus to offset this, it must be made more difficult for the steam to escape and this is done by the addition of egg to the mixture and the reduction of the shortening.

Among the explanations offered in connection with the leavening of popovers are these: The liquid present forms steam when the popover is put in a sufficiently hot oven and this steam in expanding raises the dough to the shape seen in the finished product. It is suggested that if the moisture evaporates before the crust forms sufficiently to hold it in, the texture will be more like that of a muffin. This would happen if the temperature of the oven were too low. With too hot an oven the crust would be so heavy and hard that the steam would not be able to expand

and raise it, or, to escape at all. Then the popover would be small and hard with a very moist center. Shortening is used to increase the tenderness of the crust, also to add to the flavor. The eggs give strength to the framework as well as flavor.

CREAM PUFFS

Much less time was spent on work with cream puffs than with popovers. But because of a certain popular interest in this type of flour mixture, the results are given.

Since this variety of flour mixture may be very satisfactorily made without any source of carbon dioxide and since air is not beaten into the egg mixture, it would seem that the leavening agent must be the steam produced from the liquid. Cream puffs are most satisfactorily made when baked in a hot oven, which is true of those products depending upon steam for leavening.

The finished product resembles a popover, in that it is hollow and dry, but the crust is more tender.

A change of atmospheric pressure seems to have little effect on the quality of cream puffs. Very good ones can be made at any altitude up to 11,180 feet from any sea-level recipe which does not include baking powder. Those made at higher altitudes are improved by increasing the quantities of water and of egg.

PROCEDURE AND RESULTS

UTENSILS.—Utensils were similar to those employed in popovers.

INGREDIENTS.—The ingredients included bread flour, butter, egg and water.

WEIGHING, MANIPULATION OF INGREDIENTS AND BAKING.—The method followed in weighing ingredients has been fully presented on pages 40-44. The manipulation for cream puffs differs from all other flour mixtures discussed.

The water and butter were placed in a pan and brought to the boiling point, then allowed to boil up well. The flour was added all at once and the mixture stirred vigorously a few seconds until it came clean from the pan, about a minute altogether. The pan was removed from the heat and allowed to cool to room temperature, then the unbeaten eggs were added 1 at a time, and were thoroly beaten into the first mixture. This paste was then placed by spoonfuls on a baking sheet, shaped by a spoon that has been dipped into cold water, and baked at a high temperature.

The baking period may be at one temperature, 450 degrees F., until done or, may be 450 degrees F. for 15 to 20 minutes, then reduced to 400 degrees F. until baked. The first-named baking temperature was used in the experiments on page 52.

TABLE 8.—CREAM PUFFS.

Variations in Proportions of Ingredients at Sea Level, at 5,000 Feet and at 11,180 Feet.

Experiment	Flour grams	Butter grams	Egg grams	Water grams	Baking powder grams	Checks	Results
Sea Level—Atmospheric pressure, 29.9 inches of mercury.							
1	37	42.0	48	59.2	....	3	Good, high, hollow, brown.
2	37	37.5	48	79.0	2.67	2	Did not rise so well as 1. Poor product.
3	37	37.5	64	79.0	0.69	2	Similar to 1, but no more satisfactory.
5,000 Feet—Atmospheric pressure, 24.9 inches of mercury.							
1	37	37.5	48	59.3	....	3	Very satisfactory product.
2	37	42.0	48	59.3	....	3	Slightly more tender than 1.
3	37	37.5	48	79.0	2.67	2	Did not rise.
4	37	37.5	64	79.0	0.69	2	Very good product.
5	37	37.5	64	79.0	....	2	Higher, more hollow than 4.
11,180 Feet—Atmospheric pressure, 19.9 inches of mercury.							
1	37	42.0	48	59.3	....	2	Quite high, crisp, brown, hollow.
2	37	37.5	64	79.0	....	3	Higher, better, more hollow than 1.

FLOUR MIXTURES LEAVENED BY CARBON DIOXIDE—BAKING-POWDER BISCUITS

One of the most popular of the flour mixtures is the baking-powder biscuit. It is the simplest type of the group leavened by carbon dioxide and the most easily and most quickly made by the experienced, yet often the despair of the uninitiated.

The ideal biscuit is uniform in shape, at least twice as high after baking as before, with a delicate, brown crust top and bottom. The crumb is of an even whiteness, light, springy to the touch and particles of the inner part flake off rather than crumble. The crumb feels soft in the mouth, but does not become doughy. It has a delicate, pleasing taste.

Biscuits contain only flour, leavening agent, salt, liquid and fat. Their simplicity would imply a uniformity in recipes and results which is found not to be so in the inspection of the formulas in cookbooks.

RANGE IN PROPORTIONS OF INGREDIENTS QUOTED IN BAKING-POWDER BISCUIT RECIPES.

	Flour cup	Baking powder teaspoon	Salt teaspoon	Fat tablespoon	Liquid cup	Baking temperature ° F.
Minimum	2	2	⅛	2	⅔	400
Maximum	2	5	1½	5	1½	475

Several variable factors, difficult to standardize, such as absorption capacity of the flour, manipulation and personal opinion, may account to some extent for this lack of agreement and for the difficulties encountered by the inexperienced in making a first-class product.

The quality of biscuits, it is believed, depends chiefly on two factors—the amount of liquid added and the thoroness of combining. The usual recipe states definitely the amount of flour, baking powder, salt and shortening but prefixes the amount of liquid with the word "about." Or it may read, "add sufficient milk to make a soft dough." Both of these expressions are most indefinite to the beginner who cannot yet tell by the touch whether the dough is of the right degree of softness. There is a reason for this qualification in the recipe. Biscuits are usually made from bread flour or an all-purpose flour. This flour differs with each brand in the amount of moisture it absorbs; it even differs with different sacks of the same brand. For this reason it is almost impossible to state the exact amount of liquid required, and the quantity of liquid must be determined by experience. Also, the kind of liquid chosen plays a large part. More milk is required than water because milk is only 87 percent water. The dough should be soft and light but just miss being sticky when placed on the board. The first couple of turns in kneading should give a smooth-surfaced dough.

Manipulation has been found to be one of the chief variables in making biscuits. The two sets of directions most commonly used are given and will be referred to by number in tables to follow:

MANIPULATIONS FOR BAKING BISCUITS.

1. Sift the dry ingredients, cut in the fat with two knives. Add the milk and stir just enough to moisten the flour. Turn out onto a sligntly floured board, pat or roll out to about one-half inch thickness, cut into shape and bake in a quick oven.

2. Sift the dry ingredients, mix in the fat by gently rubbing it between tne fingers and thumb, until the consistency of cornmeal when finished. Mix the milk with the dry ingredients by putting in the milk all at once and stirring gently until moistened and then vigorously for several seconds. Have the board slightly floured and turn the dough onto it, removing the mixture from the bowl with the spatula. Knead quickly for several seconds. Pat or roll one-half to three-quarters inch thick. Bake in a hot oven.

The first manipulation is based on the belief that rapid mixing is the secret of success; the second, on the belief that thoro mixing is of paramount importance. The results of the experiments bear out the second.

An interpretation in keeping with facts presented in the earlier discussion is that the fat tends to separate the continuous strands of the gluten, and this produces the tender, flaky texture desired.

In experimental work it was found that when sufficient liquid was added to give a soft dough and thoroly mixed with the dry ingredients, results were better than when the dough was more stiff and more compact. Miss Halliday reports results in her recently published book, "Hows and Whys of Cooking"[14] in agreement with this.

The temperature at which the biscuits are baked is important. If too low, the amount of evaporation before the coagulation of the batter takes place is excessive and the product is dry and crumbly. The oven should be hot enough to coagulate the outside very quickly so that enough moisture will be left within the biscuit by the time it is baked to leave it delicate, light and flaky.

Personal preference is a larger factor in this type of baked product than in many others. There are those who prefer a biscuit similar in appearance to a yeast roll. This type is produced by using a relatively large amount of baking powder and a small amount of fat. Others consider the biscuit that is richer, with a light but very tender, flaky texture to be of higher quality. This type of biscuit is produced by using a relatively small amount of baking powder and a large amount of fat.

PROCEDURE AND RESULTS

UTENSILS.—The utensils employed in this set of experiments included scales, weights, 2-quart mixing bowl, 1-pint enamel bowl, flour sifter, rolling pin, wooden spoon, measuring spoons, spatula, brushes, baking tin, biscuit cutter and oven thermometer.

INGREDIENTS.—The ingredients included bread flour, salt, baking powder, shortening and liquid.

WEIGHING.—The procedure for weighing the ingredients is discussed on pages 40-44.

In the five tables to follow are given the results in which the methods of manipulation and proportions of ingredients were studied.

TABLE 9.—BAKING-POWDER BISCUITS.

A Study of the Influence of the Method of Manipulation at 5,000 Feet. Atmospheric Pressure, 24.9 Inches of Mercury.

Experiment	Baking powder tartrate grams	Flour grams	Salt teaspoon	Fat grams	Milk grams	Baking temperature ° F.	Method of manipulation	Checks	Results
1	7.7	112	¼	33.9	87.0	425	1	2	Too compact, uneven, spotted, not so high as 2.
2	7.7	112	¼	33.9	87.0	425	2	10	Very light and flaky, even in shape and texture.
3	8.0	112	¼	25.0	91.5	425	1	4	Quite light but not so even in shape and grain as 4.
4	8.0	112	¼	25.0	91.5	425	2	6	Very soft, flaky and tender, even in shape and grain.

Since mixing according to the second method gave the better results, that method was used thruout the experiments reported in Tables 10, 11 and 12. The baking temperature was 425 degrees F. The time averaged 15 minutes. This gave a delicately browned product.

TABLE 10.—BAKING-POWDER BISCUITS.

Variations in Proportions of Ingredients at Sea Level. Atmospheric Pressure, 29.9 Inches of Mercury.

Experiment	Baking powder tartrate grams	Flour grams	Salt teaspoon	Fat grams	Milk grams	Checks	Results
1	12.0	113	¼	18.8	141.0	2	Smooth top, too soft, did not hold shape. light, tender.
2	9.0	113	¼	12.5	91.5	2	Doubled in height, good texture, well browned, light, fluffy.
3	8.0	113	¼	25.0	91.5	7	Very good, light, fluffy and flaky, white, even grained, tender.
4	8.0	113	¼	12.5	122.0	2	Harder to handle than 5, not quite so soft, not so rich and flaky as 3.
5	8.0	113	¼	12.5	91.5	5	Similar to 2, not so rich and flaky as 3, lighter than 4.
6	7.7	113	¼	33.9	87.0	6	Similar to 3, but slightly richer.
7	8.0	113	¼	25.0	91.5	3	Not so high and light as 3.

TABLE 11.—BAKING-POWDER BISCUITS.

Variations in Proportions of Ingredients at 5,000 Feet. Atmospheric Pressure, 24.9 Inches of Mercury.

Experiment	Baking powder tartrate grams	Flour grams	Salt teaspoon	Fat grams	Milk grams	Checks	Results
1	8.0	113	¼	25.0	91.5	6	Good, fine, even grained, flaky, tender.
2	8.0	113	¼	12.5	152.5	1	Much too soft a dough, did not hold shape. Hard to handle. Not so light as 1.
3	8.0	113	¼	12.5	122.0	2	Better but still too moist without the addition of flour to knead.
4	8.0	113	¼	12.5	91.5	3	Not so rich and flaky as 1 but light, tender and fluffy, even grained.
5	7.7	113	¼	33.9	87.0	10	Similar to 1.
6	7.0	113	¼	25.0	91.5	5	Best of this group.

TABLE 12.—BAKING-POWDER BISCUITS.

Variations in Proportions of Ingredients at 11,180 Feet. Atmospheric Pressure, 19.9 Inches of Mercury.

Experiment	Baking powder tartrate grams	Flour grams	Salt teaspoon	Fat grams	Milk grams	Checks	Results
1	8.0	113	¼	25.0	91.5	2	Very high, light and fluffy, slightly too loose.
2	7.0	113	¼	25.0	91.5	3	Slightly better than 1
3	6.0	113	¼	25.0	91.5	3	Light, flaky and soft, but slightly coarse.
4	6.0	113	¼	18.8	91.5	6	Best of all, similar to 3 but finer grained.
5	8.0	113	¼	12.5	122.0	2	Dough hard to handle. High and light, good grain.
6	7.0	113	¼	12.5	91.5	4	Not so rich and flaky as 4 but light and very good.

CONCLUSION

A change in atmospheric pressure has very little effect upon the baking of this product. The illustration shows the very slight difference in biscuits baked from the same recipe, with the same weights of ingredients, manipulation and baking temperature, at varying atmospheric pressures. The first biscuits were baked at a

TABLE 13.—BAKING-POWDER BISCUITS.

Summary of Results Presented in Tables 10, 11 and 12. The Optimum Proportions of Ingredients at Sea Level, at 5,000 Feet and at 11,180 Feet.

Ingredients	Sea Level (29.9 inches) grams	5,000 Feet (24.9 inches) grams	11,180 Feet (19.9 inches) grams
Baking Powder* (Tartrate)	8 (2⅛ t.)**	7 (1⅞ t.)	6 (1⅝ t.)
Salt	(¼ t.)	(¼ t.)	(¼ t.)
Flour	113 (1 c.)	113 (1 c.)	113 (1 c.)
Fat	31.25 (2½ T.)	25 (2 T.)	18.75 (1½ T.)
Milk	91.5 (⅜ c.)	91.5 (⅜ c.)	91.5 (⅜ c.)
*S. A. S. Baking Powder	6 (1½ t.)	5.25 (1 5/16 t.)	4.5 (1⅛ t.)

**For abbreviations used in this table see footnote of Table 6.

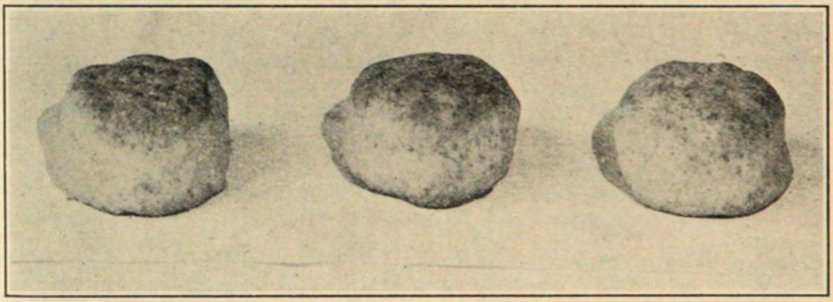

Fig. 9.—Baking-powder biscuits at sea level, at 5,000 feet and at 11,180 feet, using the same recipe at the three altitudes.

pressure of 29.9 inches of mercury (sea level), the second at 24.9 inches of mercury (5,000 feet) and the third set at 19.9 inches of mercury (11,180 feet).

Here, as in every product leavened by carbon dioxide, the amount of gas formed from a definite weight of baking powder, or soda, expands to an increasingly larger volume at 425 degrees F. as the elevation increases and the atmospheric pressure decreases. The texture thus becomes looser and fluffier. In order to produce results corresponding to those at sea level, the amount of baking powder and fat are slightly decreased. The dough should be slightly softer at the higher altitudes.

TABLE 14.—BAKING-POWDER BISCUITS.

Proportions of Ingredients for the Range in Altitudes Between Sea Level and 15,500 Feet.

Flour........................113 grams (1 cup)
Milk........................ 91.5 grams (6 tablespoons) Baking temperature 425° F.
Salt........................ ½ teaspoon

Atmospheric pressure inches	Altitude feet	Baking powder		Fat	
		Tartrate or grams*	S. A. S. grams*	Butter or grams*	100 percent fat** grams*
29.9	Sea level	8.0	6.0	35.0	31.3
		2⅛ t.	1½ t.	2½ T.	2½ T.
28.9	1,018	7.8	5.9	33.6	30.0
		2 t.	1½ t.	2 T. + 1¼ t.	2 T. + 1¼ t.
27.9	1,977	7.6	5.7	32.2	28.8
		2 t.	1⅜ t.	2 T. + ¾ t.	2 T. + ¾ t.
26.9	3,000	7.4	5.6	30.8	27.5
		1⅞ t.	1⅜ t.	2 T. + ½ t.	2 T. + ½ t.
25.9	4,004	7.2	5.4	29.4	26.3
		1⅞ t.	1⅜ t.	2 T.	2 T.
24.9	5,000	7.0	5.3	28.0	25.0
		1⅞ t.	1⅜ t.	2 T.	2 T.
23.9	6,200	6.8	5.1	26.6	23.8
		1¾ t.	1¼ t.	2 T. — ¼ t.	2 T. — ¼ t.
22.9	7,380	6.6	5.0	25.2	22.5
		1¾ t.	1¼ t.	2 T. — ½ t.	2 T. — ½ t.
21.9	8,500	6.4	4.8	23.8	21.3
		1⅝ t.	1¼ t.	2 T. — 1 t.	2 T. — 1 t.
20.9	9,820	6.2	4.7	22.4	20.0
		1⅝ t.	1⅛ t.	2 T. — 1¼ t.	2 T. — 1¼ t.
19.9	11,180	6.0	4.5	21.0	18.8
		1½ t.	1⅛ t.	1½ T.	1½ T.
18.9	12,500	5.8	4.4	19.6	17.5
		1½ t.	1⅛ t.	1 T. + 1¼ t.	1 T. + 1¼ t.
17.9	14,000	5.6	4.2	18.2	16.3
		1½ t.	1 t.	1 T. + 1 t.	1 T. + 1 t.
16.9	15,500	5.4	4.1	16.8	15.0
		1⅜ t.	1 t.	1 T. + ½ t.	1 T. + ½ t.

*Except where measurements are given in teaspoons or tablespoons, the weights are in grams.
**Crisco, Snowdrift, lard, etc. These may be used in place of butter according to table.

MUFFINS

The muffin forms the link between the baking-powder biscuit and the butter cake. The muffin and the cake contain the same ingredients as does the biscuit and in addition, egg and sugar. In the muffin the latter two ingredients are present in a relatively small amount. The following tabulation, based on 2 cups of flour and giving the quantity of ingredients in the nearest whole numbers, illustrates this point:

COMPARISON OF THE BAKING-POWDER BISCUIT, THE MUFFIN AND THE PLAIN BUTTER CAKE WITH RESPECT TO THE KIND AND THE PROPORTIONS OF INGREDIENTS.

Product	Baking powder teaspoon	Flour cup	Salt teaspoon	Sugar tablespoon	Fat tablespoon	Eggs	Liquid cup
Biscuit...........	4	2	½	......	4–5	......	¾
Muffin............	4	2	½	2–4	3–4	1	1
Plain Cake......	4	2	⅔	16	4	1	1

The consistency of the muffin batter is about midway between that of baking-powder biscuit and cake, but the muffin differs from the other two in texture and in the method of combining.

An ideal muffin is golden brown in color with a flat or very slightly rounded upper crust, which is slightly rough, not smooth and glazed. It is light and fluffy with a uniform texture and resembles very light, loose cake. It has no tunnels.

Some muffins are much like bread in flavor. Others are sweet and tender of crumb, resembling a plain cake. Hence in this type of flour mixture as also in others, personal preference is an important factor to be considered when choosing a recipe. A study of muffin recipes shows a wide range of variation in the proportions of ingredients as indicated in the following tabulation:

RANGE IN PROPORTIONS OF INGREDIENTS QUOTED IN MUFFIN RECIPES.

	Flour cup	Baking powder teaspoon	Salt teaspoon	Sugar tablespoon	Fat tablespoon	Eggs	Milk cup	Baking temperature ° F.
Minimum	2	3½	¼	1	2	1	¾	370
Maximum	2	5	1½	4	4	2	1	425

PROCEDURE AND RESULTS

UTENSILS.—The utensils employed included balances, weights, 2-quart mixing bowl, three small enamel bowls, flour sifter, wooden mixing spoon, measuring spoons, spatula, egg beater, the usual muffin tins and oven thermometer.

INGREDIENTS.—The ingredients employed were bread flour, baking powder, sugar, salt, fat, egg, liquid. It will be noted in the tabulated report that in all experiments the quantities of flour, salt and milk used were kept constant.

WEIGHING.—In the weighing of baking powder, flour, sugar, fat, liquid and egg the detailed procedure previously outlined on pages 40-44 was followed.

MANIPULATION.—Of the two sets of directions discussed below, the first was followed in these experiments. The work of other investigators has shown that the shorter the time of mixing and the fewer the motions, the better the results obtained.

1. Sift dry ingredients into the mixing bowl. Combine the beaten egg, liquid and melted fat. Pour the liquid ingredients all at once into the dry and stir vigorously until the dry ingredients are **just dampened.** Place the batter in the pans by dipping it up with as little stirring as possible.[14]

2. Sift the dry ingredients into the bowl. Break the eggs into the dry ingredients, add the milk a little at a time, and beat well until smooth. Add the melted shortening, mix well by stirring but do not beat. Fill muffin tins half full.

BAKING TEMPERATURE.—The baking temperatures employed when a tartrate baking powder was used was 425 degrees F. When a S. A. S. type of baking powder was used, the muffins were placed in an oven with an initial temperature of 300 degrees F., and the heat increased rapidly to 425 degrees F. The time required for the crust to become golden brown was approximately 20 minutes.

TABLE 15.—MUFFINS.

Variations in Proportions of Ingredients at Sea Level. Atmospheric Pressure, 29.9 Inches of Mercury

Flour	113 grams (1 cup)
Milk	122 grams (½ cup)
Salt	¼ teaspoon

Experiment	Baking powder grams	Sugar grams	Fat grams	Eggs grams	Checks	Results
	Tartrate					
1	8.0	25.0	28.0	24.0	5	Fine texture, quite evenly grained, tender, sweet.
2	8.0	25.0	21.0	24.0	2	Similar to but not quite so tender as 1.
3	8.0	12.5	21.0	24.0	3	More like a bread, but not so sweet and tender as 1 and 2. Even grained tho slightly coarser than 2.
4	7.0	12.5	21.0	24.0	2	Not quite so light as 3.
5	8.0	18.8	21.0	24.0	2	Slightly sweeter than 4. No other apparent change.
6	8.0	12.5	21.0	48.0	2	Too much egg. Not so satisfactory as preceding results.
	S. A. S.					
7	8.0	12.5	21.0	24.0	3	Slightly too coarse and crumbly.
8	6.0	12.5	21.0	24.0	7	Very satisfactory; similar to 3.

TABLE 16.—MUFFINS.

Variations in Proportions of Ingredients at 5,000 Feet. Atmospheric Pressure, 24.9 Inches of Mercury.

Flour....113 grams (1 cup)
Milk....122 grams (½ cup)
Salt.... ¼ teaspoon

Experiment	Baking powder grams	Sugar grams	Fat grams	Egg grams	Checks	Results
	Tartrate					
1	8.0	25.0	28.0	24.0	2	Very good texture, but inclined to crumble. Too sweet.
2	10.0	25.0	28.0	24.0	2	Slightly more crumbly than 1. Very light.
3	8.0	25.0	21.0	24.0	2	Light and with good grain.
4	8.0	12.5	21.0	24.0	4	Very good, light, even texture.
5	7.0	12.5	21.0	24.0	3	Quite satisfactory.
6	7.0	12.5	14.0	24.0	2	Not tender enough
7	6.0	25.0	28.0	24.0	2	Good but not so light and fluffy as 1.
	S. A. S.					
8	5.3	12.5	21.0	24.0	2	Similar to 5.

TABLE 17.—MUFFINS.

Variations in Proportions of Ingredients at 11,180 Feet. Atmospheric Pressure, 19.9 Inches of Mercury.

Flour....113 grams (1 cup)
Milk....122 grams (½ cup)
Salt.... ¼ teaspoon

Experiment	Baking powder grams	Sugar grams	Fat grams	Egg grams	Checks	Results
	Tartrate					
1	8.0	25.0	28.0	24.0	2	Very tender, crumbly, too light and too loose.
2	7.0	25.0	28.0	24.0	2	Not so light as 1, still too crumbly.
3	6.0	25.0	28.0	24.0	2	Better than 1 and 2.
4	6.0	12.5	28.0	24.0	2	Less sweet than above, more like muffin texture.
5	6.0	12.5	14.0	24.0	5	Best of this group.
6	6.0	12.5	7.0	24.0	2	Not tender or rich enough.
	S. A. S.					
7	4.3	12.5	14.0	24.0	4	Very similar to 5.

None of the above products was a failure. The richer ones with the larger amounts of baking powder tended to crumble at 11,180 feet and were very loose and light. The recipe chosen is a matter of preference.

TABLE 18.—MUFFINS.

Summary of Results Presented in Tables 15, 16 and 17. The Optimum Proportions of Ingredients at Sea Level, at 5,000 Feet and at 11,180 Feet.

Ingredients	Sea level (29.9 inches) grams	5,000 Feet (24.9 inches) grams	11,180 Feet (19.9 inches) grams
*Tartrate baking powder	16	14	12
	(4⅛ t.)**	(3⅝ t.)	(3⅛ t.)
Salt	(½ t.)	(½ t.)	(½ t.)
Flour	226	226	226
	(2 c.)	(2 c.)	(2 c.)
Sugar	25–50***	25–37.5	25
	(2–4 T.)	(2–3 T.)	(2 T.)
Fat	42–56***	28–56	28–42
	(3–4 T.)	(2–4 T.)	(2–3 T.)
Milk	244	244	244
	(1 c.)	(1 c.)	(1 c.)
Egg	48	48	48
	(1)	(1)	(1)
*S. A. S. baking powder	12.0	10.5	9.0
	(3 t.)	(2⅝ t.)	(2¼ t.)

**For abbreviations used in this table see footnote of Table 6.

***When two quantities are given, the first is the amount for a plain muffin texture and the second for a richer, sweeter one. The weights given are for butter. If a vegetable compound is used, the measures will be the same and the weights based upon 12.5 grams per tablespoon.

In this type of flour mixture the carbon dioxide is the chief leavening agent. The expansion of steam plays a minor part. If the muffin batter is mixed for too long a time, tunnels appear. There is yet no satisfactory explanation for this.

With a change in atmospheric pressure one observes a change in the texture of the product similar to that found in the baking-powder biscuit. Sea-level recipes may be satisfactorily used as high as 12,000 feet without failure. At the higher elevation the crumb becomes more loose in texture and very tender, but the degree of success depends upon the sea-level recipe chosen.

The muffins shown in the accompanying illustration were prepared and baked at sea level, at 5,000 feet and at 11,180 feet. The same proportion of ingredients, manipulation and baking temperature were used.

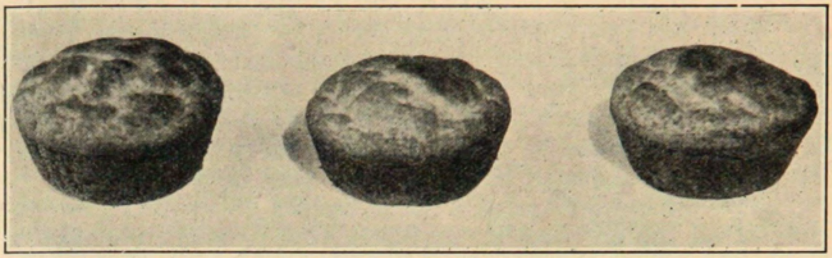

Fig. 10.—Muffins at sea level, at 5,000 feet and at 11,180 feet, using the same recipe at the three altitudes.

TABLE 19.—MUFFINS.

Proportions of Ingredients for the Range in Altitudes Between Sea Level and 15,500 Feet.

Flour	226 grams (2 cups)	Egg	48 grams (1)
Salt	½ teaspoon	Milk	244 grams (1 cup)

Atmospheric pressure inches	Altitude feet	Baking powder: Tartrate grams	or S. A. S. grams	Sugar grams	Fat: Butter grams	or 100 percent fat grams
29.9	Sea level	16.0	12.0	25–50*	42–56*	37.5–50*
		4⅛ t.	3 t.	2 T.–4 T.	3 T.–4 T.	3 T.–4 T.
28.9	1,018	15.6	11.7	25–50	42–56	37.5–50
		4 t.	3 t.	2 T.–4 T.	3 T.–4 T.	3 T.–4 T.
27.9	1,977	15.2	11.4	25–45.9	37.4–56	33.4–50
		4 t.	2⅞ t.	2 T.–3⅔ T.	2⅔ T.–4 T.	2⅔ T.–4 T.
26.9	3,000	14.8	11.1	25–45.9	37.4–56	33.4–50
		3⅞ t.	2¾ t.	2 T.–3⅔ T.	2⅔ T.–4 T.	2⅔ T.–4 T.
25.9	4,004	14.4	10.8	25–41.7	32.7–56	29.2–50
		3¾ t.	2¾ t.	2 T.–3⅓ T.	2⅓ T.–4 T.	2⅓ T.–4 T.
24.9	5,000	14.0	10.5	25–37.5	28–56	25–50
		3⅝ t.	2⅝ t.	2 T.–3 T.	2 T.–4 T.	2 T.–4 T.
23.9	6,200	13.6	10.2	25–37.5	28–56	25–50
		3½ t.	2½ t.	2 T.–3 T.	2 T.–4 T.	2 T.–4 T.
22.9	7,360	13.2	9.9	25–33.3	28–51.4	25–45.9
		3⅜ t.	2½ t.	2 T.–2⅔ T.	2 T.–3⅔ T.	2 T.–3⅔ T.
21.9	8,500	12.8	9.6	25–33.3	28–46.7	25–41.7
		3¼ t.	2⅜ t.	2 T.–2⅔ T.	2 T.–3⅓ T.	2 T.–3⅓ T.
20.9	9,820	12.4	9.3	25–29.1	28–42	25–37.5
		3¼ t.	2¼ t.	2 T.–2⅓ T.	2 T.–3 T.	2 T.–3 T.
19.9	11,180	12.0	9.0	25.0	28–42	25–37.5
		3⅛ t.	2¼ t.	2 T.	2 T.–3 T.	2 T.–3 T.
18.9	12,500	11.6	8.7	20.9	28–37.4	25–33.4
		3 t.	2¼ t.	1⅔ T.	2 T.–2⅔ T.	2 T.–2⅔ T.
17.9	14,000	11.2	8.4	16.7	23.8–28	20.9–25
		3 t.	2⅛ t.	1⅓ T.	1⅔ T.–2 T.	1⅔ T.–2 T.
16.9	15,500	10.8	8.1	12.5	23.8–28	20.9–25
		2⅞ t.	2 t.	1 T.	1⅔ T.–2 T.	1⅔ T.–2 T.

*See footnote of Table 18.***

OTHER QUICK BREADS

When the recipe for a light bread, or fruit-and-nut bread, requires small amounts of baking powder and sugar, the recipe may be used with good success at any altitude. But in those recipes which require a large amount of sugar, this amount must be slightly decreased as the altitude increases. The amount of liquid required depends largely on the kind of flour used.

Most coffee-cake and short-cake recipes give satisfactory results at all the altitudes up to 12,000 feet. On making adjustments the same general suggestions hold as were cited in the report on muffins.

BUTTER CAKES—FOUNDATION BUTTER CAKES AND VARIATIONS

This type of flour mixture forms the largest and most complex group with the greatest number of variations. To the inexperienced housewife it appears that there must be an almost unlimited number of proportions of ingredients which produce cakes and she is quite at a loss to know which to choose. For unless one has made careful study of the subject, one is unable to tell by reading a recipe just what sort of cake will result. In many instances much time, labor and material are wasted in trying out new recipes which are in no way so satisfactory as some already tested. There is no intention to discourage the experimental attitude, but rather it is the aim to explain the fundamental facts so that one may experiment intelligently. If one has several excellent basic formulas, the extent of variation is great.

A high-grade cake, tho difficult to describe, has the following characteristics: The top is flat or only slightly rounded; the crust is a delicate brown, which deepens somewhat in color with the richness of the cake; a cross section shows a thin, tender crust and a fine, even grain; the crumb should be just moist enough to give resiliency and a delicate fluffiness in texture. The degree of resiliency is indicated in this manner—the cake is gently pressed between the fingers, then when released, there should be a spongy feel and an instantaneous springing back to its original form. To test its tenderness a cross section of the cake, of ordinary thickness, is held in the two hands with the fingers touching underneath and the thumbs on top, but not together. As the fingers are raised gently the piece rests across them as a fulcrum and the amount of pressure by the thumbs on the top of the piece, necessary to break the cake is taken as the measure of its tenderness, being of course, inversely proportional. An excellent cake requires practically no pressure at all to effect an even cleavage. Whatever may be the kind of flavor desired it should be characterized by delicacy.

The lack of agreement among authorities as to standard proportions for each particular type of flour mixture was most pronounced in the case of cakes. There are all sizes of cakes and a great range of proportions of ingredients. In order to have some basis on which to work, it was decided that all cakes to be studied should be approximately the same size to facilitate comparison. Three cups of pastry flour, 300 grams, were chosen as the standard amount of flour in each cake. This amount makes one loaf in the average angel-food or tube pan, two loaves in medium-sized bread pans, two layers in pans 8x8x1¾ inches and about 24 cup cakes, muffin size. One-half of the recipe is easily handled for one layer or one medium loaf and two-thirds of the recipe makes the two smaller round layers sometimes used.

The first cakes studied were the foundation butter cakes, which are those containing flour, baking powder, salt, sugar, shortening, milk and whole eggs. All foundation butter cakes contain these same ingredients but differ slightly in quality and texture according to the proportion of each ingredient present. Since it was necessary to adopt some basis for studying these cakes, and since recipes which call for whole eggs are more convenient for use than those which require a fractional part of an egg, it was decided that the 1-egg, the 2-egg, the 3-egg and the 4-egg cake recipes were well suited to the purpose of this project.

According to this classification, a series of four groups of cakes was formed. The first group contained 1 egg to 3 cups of flour and was called the "1-Egg Foundation Cake." In like manner were chosen the 2, the 3 and the 4-egg foundation cakes. This series might be extended but the experimental work included just these four, as it was felt that the 4-egg foundation cake was the richest cake which would ordinarily be required. However, the graphs given make it a simple matter to compute a richer cake if one is desired (see pages 135 to 137).

Recipes taken from standard cookbooks and magazines were computed on the basis of 3 cups of flour and classified accordingly. The following tabulation shows the range of variations encountered:

Range of Proportions of Ingredients Quoted in Foundation Butter-Cake Recipes.

	Flour cup	Baking powder teaspoon	Salt teaspoon	Sugar cup	Fat cup	Egg	Milk cup	Baking temperature
			1-Egg Foundation Butter Cake					
Only one recipe found	3	6	1	1½	¼	1	1½	Moderate
			2-Egg Foundation Butter Cake					
Minimum	3	3	....	1	½	2	1	Moderate
Maximum	3	6	1	1½	½	2	1	Moderate
			3-Egg Foundation Butter Cake					
Minimum	3	1	....	1¼	½	3	¾	Cold oven–275° F.
Maximum	3	5	1	2	¾	3	1½	380° F.
			4-Egg Foundation Butter Cake					
Minimum	3	2	....	1½	½	4	¾	Cold oven–350° F.
Maximum	3	6	1	2	1	4	1	375° F.

There was a greater range in recipes for the variations of these foundation cakes and in some instances the differences were so great that comparison was practically impossible.

From a chemical standpoint, it was believed that, atmospheric conditions being constant, a definite proportion of ingredients, combined in a definite manner and baked at a definite temperature would always, without exception, produce a definite result, just as in chemical experiments definite weights of compounds treated in a definite manner always produce identical reactions. Also, that for each type of product, one particular proportion of ingredients, a particular method of combining them and one special baking temperature should produce a result superior to the rest.

It became immediately apparent that producing the aforesaid superior product was a distinctly different problem from a chemical synthesis. In the latter case there are very definite standards and means of measurements, while in the preparation of a baked product there are many less-understood factors to take into consideration.

In the judging as well as in the preparation of a cake the personal equation plays a large part. There is no evidence to show that there is an absolute standard by which a cake may be judged. The most common method is the use of scorecards and these are of value in selecting the best cake of a certain group when one particular card is used. Even when using the same scorecard, two people may not score alike. Two cakes having the same score may yet be quite unlike. It was therefore decided to attempt a description in words for each product rather than to resort to the use of scorecards.

By recalling the chemistry involved in mixing and baking flour mixtures, it is realized that a definite relationship exists among the quantities of the ingredients and that each has a definite function to perform. From the flour come the gluten strands, which form the framework or structure of the cake. The tiny holes are caused by the gas liberated from the leavening agent, expansion of incorporated air and the expansion of steam. The sugar and shortening make the cake tender and palatable. The egg aids in toughening the fibers of the framework and in emulsifying the fat. The liquid is necessary for the solution and dispersion of the various ingredients, aids leavening, and gives the proper consistency to the finished product. Every proportion of these ingredients produces a cake with definite characteristics. Each time egg is added, an emulsifying agent is added and the fibers are strengthened so that fat and sugar may be added to the batter. When an egg is thoroly beaten, air is incorporated which later acts as a leavening agent in baking. Thus the amount of baking powder may be decreased as egg is added. The egg also contains water so that the amount of liquid may be decreased. Experiments showed that these variations may be definitely calculated. But when the amount of flour and the number of eggs have been determined, the quantities of the other ingredients become fixed amounts if the most satisfactory result is to be obtained. Tho the following experiments are based on 3 cups of flour, the proportion of ingredients for any amount of flour may be calculated from these formulas.

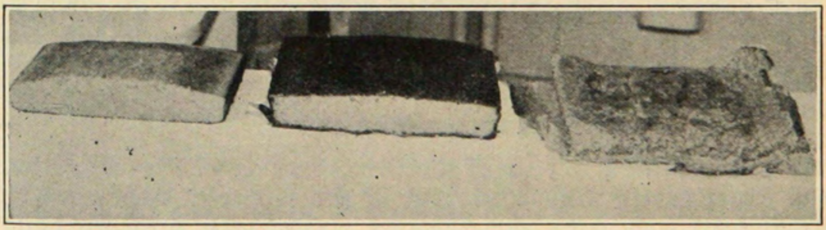

Fig. 11.—Two-egg foundation butter cakes at sea level, at 5,000 feet and at 11,180 feet, using the same recipe at the three altitudes.

A change of atmospheric pressure or altitude has greater effect upon butter cakes than upon any other type of flour mixture. Figure 11 shows the outsides of 2-egg foundation butter cakes baked at three altitudes from the same recipe. Figure 12 shows the outsides and cross-sections of 4-egg foundation butter cakes also baked at three altitudes, and from the same recipe. It

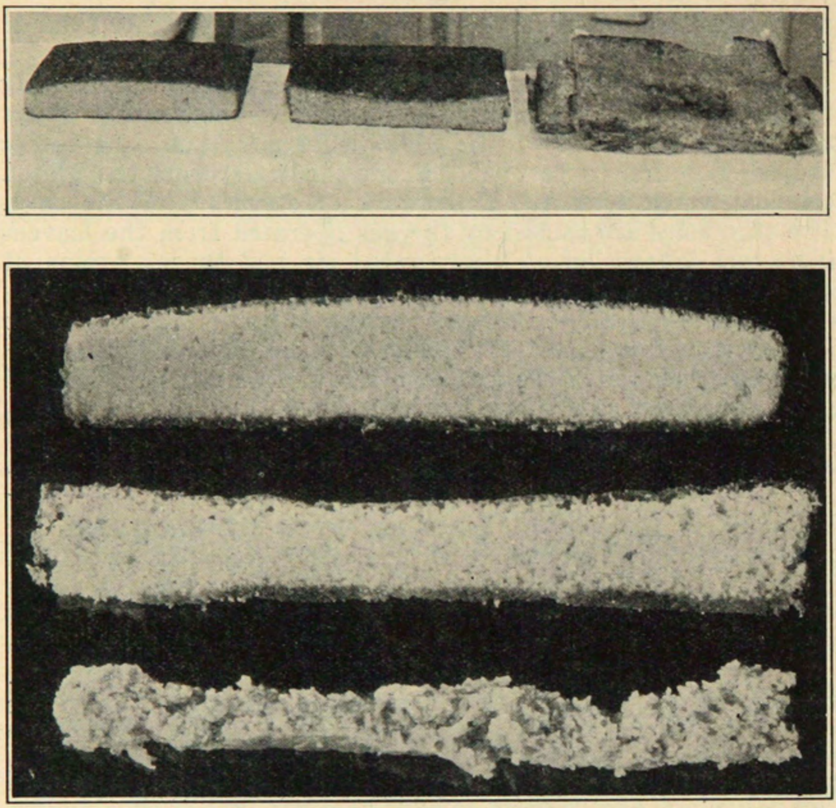

Fig. 12.—Four-egg foundation butter cakes at sea level, at 5,000 feet and at 11,180 feet, using the same recipe at the three altitudes.

will be noted that the richer cake is more pronouncedly affected by altitude than is the plain cake.

PROCEDURE AND RESULTS

During the first year of the time spent on this investigation the experiments were conducted in the research laboratory at 5,000 feet, with such variations of atmospheric pressure from day to day as occur at any elevation. A check of these first experiments was later made in the altitude laboratory and all subsequent experiments conducted there under controlled atmospheric pressures. It is impossible to list in this work every experiment performed because very nearly 1,300 cakes were made. Also, the experiments are not listed in chronological order, but are arranged to show the conclusions drawn with respect to each variable.

UTENSILS.—The utensils assembled for the series of experiments with cakes included scales, weights, 3-quart mixing bowl, 1-quart mixing bowl, four enamel bowls, wooden spoon, measuring spoons, spatula, flour sifter, brushes, large tablespoon, cake pan, oven thermometer and cake racks.

INGREDIENTS.—The ingredients that were used in making all butter cakes of this series were cake flour, the three types of baking powder, salt, granulated beet sugar, butter, eggs and milk (see pages 28 to 35 for discussion of ingredients.)

WEIGHING.—The technic employed is given on pages 40-44. The usual order observed in making the weighings was as follows: Baking powder, flour, sugar, butter, milk and egg.

MANIPULATION OF INGREDIENTS.—Since manipulation is a very important factor in cake making, this constituted the first study. The procedure is given in detail. Before mixing the cake the pan was prepared. For a loaf cake either a tube pan or a bread pan was used. The former was oiled and floured lightly. The latter was oiled, then the bottom and two longest sides were lined with waxed paper and again oiled lightly. For a layer cake the pan was oiled and lined with waxed paper, then oiled again. The paper was made smooth on the bottom and the sides, and the extra paper, forming the corners of the square, was folded smoothly into each corner.

Tho the best of materials be used and in correct proportion, they may be so combined that the result is far from satisfactory. To insure evenness of texture and a fine grain, the batter must be in the form of an emulsion. By this is meant that each ingredient in the batter has been divided and subdivided into exceedingly minute particles which are dispersed in, or uniformly distributed thruout a medium, so that the resulting material is a homogeneous mass.

A study of colloidal solutions, especially emulsions, indicates that the method of forming an emulsion is one of the important factors in its preparation. This point may be illustrated clearly in the case of mayonnaise dressing which is a familiar example of an emulsion. It is a well-known fact that the egg and seasonings must be thoroly mixed, and the oil added a small amount at a time in the beginning if a satisfactory emulsion is to result. The same principle holds true for cake. If the materials are so put together that an emulsion is formed, the resulting cake will be finer in texture and lighter than in a mixture not so characterized.

Various methods of manipulation are advocated, but only those which produce an emulsion will give satisfactory results. These various methods given in the form of directions, are listed below:

1. Cream the shortening and add the sugar gradually, creaming thoroly. Separate the eggs, beat the yolks until light and add to the fat-sugar mixture, blend well. Sift the dry ingredients, add alternately with the liquid, add the flavoring. Beat the egg-whites stiff and fold in at the last.
2. The same method as the first except that the eggs are not separated but beaten well and added to the fat-sugar mixture, then all beaten well.
3. The same as the first method except that half of the sugar is beaten into the egg-yolks.
4. The same as the first method except that one-third of the sugar is beaten into the egg-yolks and one-third into the egg-whites.
5. The same as the second method except that half the sugar is beaten into the eggs.
6. Beat the eggs and add the milk. Sift all the dry ingredients into the mixing bowl, pour in the liquid ingredients and mix thoroly; add the melted butter last and beat well.
7. Rub the fat into the flour, add the sugar and mix well. Combine the liquid ingredients and add to the dry. Beat well.

BAKING TEMPERATURES.—The baking temperatures and quantities used in Tables 20 to 25 are as follows:

Loaf in tube pan, full recipe	350° F.	1 hour
Loaf in bread pan, one-half recipe	350°—375° F.	1 hour
Layer, one-half recipe	375°—400° F.	30 minutes
Cup cakes, 12, one-half recipe	400°—425° F.	25 minutes

DETERMINATION OF THE MOST SATISFACTORY METHODS OF MANIPULATION

TABLE 20.—One-Egg Foundation Butter Cake.

A Study of the Influence of the Method of Manipulation at Sea Level. Atmospheric Pressure, 29.9 Inches of Mercury.

Baking powder	22 grams	Fat	70 grams
Flour	300 grams	Milk	366 grams
Salt	1 teaspoon	Egg	48 grams
Sugar	300 grams	Flavoring	1 teaspoon

Experiment	Manipulation	Size	Checks	Results
1	1	Layer	2	Quite fine grained, light, tender, a few small holes.
2	2	Layer	2	Similar, but of slightly more even texture than 1.
3	3	Layer	2	No noticeable difference from 1.
4	4	Layer	2	Similar to above, slightly more even than 1 and 3.
5	5	Layer	2	Similar to 2 and 4, good, fine, even grained.
6	6	Layer	2	Light and fluffy but very much coarser and with more holes than above.
7	7	Layer	2	Not satisfactory. Coarse and slightly heavy. Manipulation difficult.
8	1	Cup	2	Very tender, light, fine grained.
9	2	Cup	2	Similar to 8.
10	3	Cup	2	Similar to 8.
11	4	Cup	2	Similar to 8.
12	5	Cup	2	Similar to 8.
13	6	Cup	2	Very light but not so fine grained as the above.
14	1	Loaf	2	Not quite so good and light as layer or cup cakes. Reasonably fine grained, tender.
15	2	Loaf	2	Similar to 14.
16	4	Loaf	2	Similar to 14.
17	6	Loaf	2	Not so fine grained as 16, inclined to be slightly heavy on the bottom, too moist.

Since manipulation 7 is rarely advocated and proved unsatisfactory, both from the standpoint of ease in making and result in baking, it was considered not worth while to include it in the other series of experiments.

TABLE 21.—Three-Egg Foundation Butter Cake.

A Study of the Influence of the Method of Manipulation at Sea Level. Atmospheric Pressure, 29.9 Inches of Mercury.

Baking powder	18 grams	Fat	154 grams
Flour	300 grams	Milk	244 grams
Salt	1 teaspoon	Egg	144 grams
Sugar	325 grams	Flavoring	1 teaspoon

Experiment	Manipulation	Size	Checks	Results
1	1	Layer	2	Light, tender and fluffy, fine grained, a few small holes.
2	2	Layer	7	Similar to 1 but with a more even texture.
3	3	Layer	2	Similar to 1.
4	4	Layer	2	Same as 2.
5	5	Layer	2	Similar to 2.
6	6	Layer	2	Coarser than 5, but tender and light, rather too moist, especially along the bottom.
7	1	Cup	2	Light, fluffy, fine grained.
8	2	Cup	2	Similar to 7.
9	3	Cup	2	Similar to 7.
10	4	Cup	2	Similar to 7.
11	5	Cup	2	Similar to 7.
12	6	Cup	2	Looser and coarser in texture and more moist than 7 to 11.
13	1	Loaf	2	Very light, tender, a very few small holes.
14	2	Loaf	2	Similar to, but slightly more even grained than 13.
15	4	Loaf	2	Similar to 2.
16	6	Loaf	2	Too moist and coarse, heavy layer on bottom, looser than 13 to 15.

TABLE 22.—One-Egg Foundation Butter Cake.

A Study of the Influence of the Method of Manipulation at 5,000 Feet. Atmospheric Pressure, 24.9 Inches of Mercury.

Baking powder	16 grams	Fat	56 grams
Flour	300 grams	Milk	366 grams
Salt	1 teaspoon	Egg	48 grams
Sugar	287.5 grams	Flavoring	1 teaspoon

Experiment	Manipulation	Size	Checks	Results
1	1	Layer	2	Tender, light, fluffy, fine grained, few holes.
2	2	Layer	12	Similar to 1, but fewer holes.
3	3	Layer	2	Similar to above.
4	4	Layer	2	Practically the same as 2.
5	5	Layer	2	Same as 2.
6	6	Layer	2	Fluffy and light but with a coarser, looser texture than 5 and with a tendency toward holes.
7	1	Cup	2	Very good, light and fluffy, fine grained.
8	2	Cup	2	Similar to 7.
9	3	Cup	2	Similar to 7.
10	4	Cup	2	Similar to 7.
11	5	Cup	2	Similar to 7.
12	6	Cup	2	Light and fluffy. More moist, coarser, looser, tnan above.
13	1	Loaf	2	A few holes but light and tender, quite fine grained.
14	2	Loaf	2	Good, light and tender, quite even grained.
15	4	Loaf	2	Similar to 14.
16	6	Loaf	2	A heavy layer on bottom, too moist, much coarser and looser than above.

TABLE 23.—Three-Egg Foundation Butter Cake.

A Study of the Influence of the Method of Manipulation at 5,000 Feet. Atmospheric Pressure, 24.9 Inches of Mercury.

Baking powder	12 grams	Fat	140 grams
Flour	300 grams	Milk	244 grams
Salt	1 teaspoon	Egg	144 grams
Sugar	275 grams	Flavoring	1 teaspoon

Experiment	Manipulation	Size	Checks	Results
1	1	Layer	2	Fine grained, light, fluffy, very few small holes.
2	2	Layer	6	Similar to 1, slightly more even in texture.
3	3	Layer	2	Similar to 2.
4	4	Layer	2	Similar to 2.
5	5	Layer	2	Similar to 2.
6	6	Layer	2	Loose and coarse but very light and tender, except for layer on bottom which was more compact and heavy.
7	1	Cup	2	Very light and fluffy, fine grained.
8	2	Cup	4	Similar to 7.
9	4	Cup	2	Similar to 7.
10	6	Cup	2	Light but coarser than above.
11	1	Loaf	2	Good, fine grained, quite even texture.
12	2	Loaf	2	Good, even grained, light, tender, fine.
13	6	Loaf	2	Not satisfactory, too crumbly, moist, with a heavy layer on bottom.

TABLE 24.—One-Egg Foundation Butter Cake.

A Study of the Influence of the Method of Manipulation at 11,180 Feet. Atmospheric Pressure, 19.9 Inches of Mercury.

Baking powder	10 grams	Fat	42 grams
Flour	300 grams	Milk	366 grams
Salt	1 teaspoon	Egg	48 grams
Sugar	237.5 grams	Flavoring	1 teaspoon

Experiment	Manipulation	Size	Checks	Results
1	1	Layer	2	Reasonably fine grained, light, a few holes.
2	2	Layer	2	Similar to 1 but with fewer holes.
3	4	Layer	2	Similar to 2.
4	6	Layer	2	Tunnels, moist, coarse and loose, crumbly.
5	1	Cup	2	Fluffy, and quite fine grained.
6	2	Cup	2	Similar to 5.
7	4	Cup	2	Similar to 5.
8	6	Cup	2	Crumbly, too coarse and loose.
9	1	Loaf	2	Some holes and not very fine grained.
10	2	Loaf	2	Slightly finer than 9, fewer holes.
11	6	Loaf	2	Almost soggy, heavy, many holes, unsatisfactory.

TABLE 25.—Three-Egg Foundation Butter Cake.

A Study of the Influence of the Method of Manipulation at 11,180 Feet. Atmospheric Pressure, 19.9 Inches of Mercury.

Baking powder	6 grams	Fat	126 grams
Flour	300 grams	Milk	244 grams
Salt	1 teaspoon	Egg	144 grams
Sugar	225 grams	Flavoring	1 teaspoon

Experiment	Manipulation	Size	Checks	Results
1	1	Layer	2	Good, fine grained, light, fluffy.
2	2	Layer	4	Similar to 1.
3	4	Layer	2	Similar to 1.
4	6	Layer	2	Coarse, heavy, moist and crumbly.
5	1	Cup	2	Light and feathery, fine grained.
6	2	Cup	2	Light and feathery, fine grained.
7	6	Cup	2	Coarse and crumbly.
8	1	Loaf	2	Quite fine grained, few holes, light.
9	2	Loaf	2	Similar to 8, fewer holes, light, tender.
10	6	Loaf	2	Coarse and soggy, heavy.

CONCLUSION

A study of the results of the above experiments shows that the sixth method may be used for simple cakes of layer or cup size, or even for cup cakes of richer batter, when the time of mixing is of prime importance. It never, however, gives a cake equal in quality to those prepared by the first five methods. The first method and its variations, the third and fourth, give cakes of practically the same quality. In the simple cakes where there is a relatively small amount of fat, adding part of the sugar to the egg, either yolk or white or both, saves time and secures slightly better results. The second method and its variation, the fifth, gives practically the same results. These latter two methods save one operation and also time by not separating the eggs. The results showed a slightly more even texture and were just as light and fluffy as those in which methods other than two and five were used. They were also a trifle more moist, which added to their delicacy. Especially in 3 and 4-egg cakes, when the eggs are separated there should be a slight increase in the amount of liquid because the whites, in being beaten stiff, lose part of their moisture and the resulting product is inclined to be somewhat drier. Also, great care should be taken to incorporate the whites completely or the texture will not be uniformly even. The chief point to remember, in selecting the method of mixing, is that the batter of the cake should be in the form of an emulsion and absolutely homogeneous.

The second method, with its variation, the fifth method, suitable for 1 and 2-egg cakes, was chosen as the standard method of mixing in the experiments to follow. The reasons for these choices were: The fewer steps in the process; ease of standardization, and uniformity and excellence in quality of results. A detailed presentation of method of mixing follows:

Success in baking cake begins with the creaming of the fat, which should always be in the solid state at the outset. Cake may be made with a liquid fat, but the results will be similar to those obtained in the above experiments with the sixth method in which the butter was melted. They are not equal in texture to those made with a solid fat. This may be due, in part, to the fact that when solid fat is thoroly creamed, air is incorated, while in just beating the liquid fat this is not true to an appreciable extent. When the creamed fat is examined under the microscope it seems to consist of myriad tiny bubbles, while there are only a few in the liquid fat. The fat should not be so hard as to make creaming difficult. It may be room temperature, but should still hold its shape. With the back of the wooden spoon the fat is rubbed against the side of the mixing bowl, the spoon flipped up slightly at the end of each stroke. This motion is continued until the fat is soft and light and about the consistency of very stiff whipped cream. The sugar is added, a tablespoon at a time, and each portion creamed thoroly into the fat. When this is done carefully the mixture will hold together and come clean from the bowl. It will be full of tiny bubbles and be light and fluffy. If the fat is liquid, or if the creaming is not done carefully, the mixture will separate into small lumps.

Since the results are quite similar it is a matter of preference whether all the sugar be creamed with the fat or part of it beaten into the egg. As was mentioned above, when the amount of fat is small, as in simple cakes, it is difficult to get all the sugar creamed into the fat, and beating part of it into the egg is a time-saver and gives even better results because of the more thoro mixing.

The eggs are beaten well. The motions for these experiments were standardized and any amount of egg up to a quantity of 2 eggs was beaten rapidly 150 times, any amount above that, 250 times. This gives a very light, airy mass. Or if the sugar is added to the eggs, the latter are first beaten 100 times, then the egg-sugar mixture is thoroly beaten.

The eggs or egg-sugar mixture are added to the fat-sugar mixture by small portions and beaten well after each addition. When all has been added the whole is beaten with an under and over motion 50 to 75 times. At this stage the mixture is light, fluffy and holds its shape. If liquid fat is used, or if the creaming is insufficient, the mixture will have a shiny appearance and seem thinner and more mobile than when done correctly. The difference is comparable to that shown by stiff whipped cream and cream that has been whipped but is not stiff enough to hold its shape.

The sifted dry ingredients and the liquid are added alternately to the fat-sugar-egg mixture. Flour is stirred in first to prevent breaking down the emulsion already formed. Flour is added last also. In simple cakes the fat-sugar-egg mixture is so stiff that only 2 or 3 tablespoons of flour may be added the first time, but in richer cakes about one-fifth of the flour may be added each time. The batter should be stirred gently after each addition of flour until there are no loose particles visible, then beaten with the under and over motion 30 to 50 times. The liquid is added in approximately equal parts and stirred in gently until well mixed, but the batter is not beaten. After the last of the flour and the flavoring have been added, the batter is beaten 100 times for each egg, i. e., 100 times for the 1-egg cake, 200 times for the 2-egg cake.

The batter is turned into the baking pan, and the last portion removed from the bowl with the spatula. The batter is pushed well up on the sides of the pan and into the corners, leaving the center lower. The cake is set in the center of the rack in the oven 3 to 4 inches above the bottom and baked at the given temperature.

When fully baked the top will be a delicate, even brown and the cake will shrink slightly from the sides of the pan. When touched lightly with the finger it will spring back and a toothpick inserted in the center of the cake will come out clean. The cake is removed from the oven and the pan is inverted on a cake rack which has been covered with a piece of waxed paper. The pan is lifted off and the paper which adheres to the cake is removed. If this is done carefully there is no danger of breaking it. Another rack, top down, is laid on the cake and the two are turned over quickly. The first rack and paper are removed at once. The cake is allowed to cool thoroly before being cut.

DETERMINATION OF THE MOST SATISFACTORY BAKING TEMPERATURES

Since there is lack of agreement as to the best baking temperatures, a series of experiments was devised for the purpose of such a study.

TABLE 26.—TWO-EGG FOUNDATION BUTTER CAKE.

A Study of the Influence of the Baking Temperatures at Sea Level. Atmospheric Pressure, 29.9 Inches of Mercury. Manipulation 5.

Baking powder	20 grams	Fat	112 grams
Flour	300 grams	Milk	304 grams
Salt	1 teaspoon	Egg	96 grams
Sugar	300 grams	Flavoring	1 teaspoon

Experiment	Baking temperature °F.	Size	Checks	Results
1	Cold—350	Layer	2	Very pale top, too compact and dry. Very fine grained but not light and fluffy, holes.
2	350	Layer	2	Slightly browner and better in every way than 1 but not equal to 3 or 4.
3	375	Layer	2	Much better than 2, fewer holes, lighter than 1.
4	375–400	Layer	4	Very good, light, feathery, fine grained, delicately browned crust, very few holes.
5	400–425	Layer	2	Crust too brown, top uneven, more holes than 4.
6	350	Cup	2	Too pale and compact, dry, not light or fluffy.
7	375	Cup	2	Better than, but not so brown or light as 8.
8	400	Cup	2	Delicate brown crust, light and fluffy, fine grained, flat top.
9	425	Cup	2	Similar to 8 but slightly browner and with a tendency to rise in center.
10	450	Cup	2	Much too brown, heavy crust, raised in center.
11	Cold—350	Loaf	2	Fine grained, not very brown, too compact.
12	350	Loaf	2	Brown top, even fine grained, light and tender.
13	375	Loaf	2	Too brown, raised slightly in center, crust thicker than 11 and 12.
14	400	Loaf	2	Too brown and too thick a crust, with crack in top.

TABLE 27.—FOUR-EGG FOUNDATION BUTTER CAKE.

A Study of the Influence of the Baking Temperatures at Sea Level. Atmospheric Pressure, 29.9 Inches of Mercury. Manipulation 2.

Baking powder	16 grams	Fat	196 grams
Flour	300 grams	Milk	183 grams
Salt	1 teaspoon	Egg	192 grams
Sugar	350 grams	Flavoring	1 teaspoon

Experiment	Baking temperature °F.	Size	Checks	Results
1	Cold—350	Layer	2	Fair, fine, very delicate brown top.
2	350	Layer	2	Slightly lighter than 1, still too pale.
3	375	Layer	5	Very good, thin delicate brown crust, light, tender, fluffy.
4	400	Layer	2	Too brown, thicker crust, texture not so good as 3.
5	425	Layer	2	Crust much too brown and thick, raised in center and cracked, texture not so even as 4.
6	350	Cup	2	Too pale, very fine grained but too dry and compact.
7	375	Cup	2	Better than 6 but not so light and fluffy as desired.
8	400	Cup	4	The best product, fine even grained, flat top, light, fluffy, tender.
9	425	Cup	2	Too brown with thicker crust, higner center, texture not so good as 8.
10	450	Cup	2	Raised in center and cracked, much too brown.
11	Cold—350	Loaf	2	Fine grained, good product, delicate top.
12	350	Loaf	2	Similar to 11, slightly browner and lighter in texture.
13	375	Loaf	2	Too brown, raised in center, texture not so even as 12.
14	400	Loaf	2	Too brown and too thick a crust, not so high or light as 12, cracked top.

TABLE 28.—ONE-EGG FOUNDATION BUTTER CAKE.

A Study of the Influence of the Baking Temperatures at 5,000 Feet. Atmospheric Pressure, 24.9 Inches of Mercury. Manipulation 5.

Baking powder	16 grams	Fat	56 grams
Flour	300 grams	Milk	366 grams
Salt	1 teaspoon	Egg	48 grams
Sugar	287.5 grams	Flavoring	1 teaspoon

Experiment	Baking temperature °F.	Size	Checks	Results
1	Cold—350	Layer	2	Compact, not brown enough.
2	350	Layer	2	Slightly less compact than 1 but still not brown enough.
3	375	Layer	3	Top crust of better color, lighter, softer texture than 2, very few holes.
4	400	Layer	4	The best of this group, delicate brown, very light and fluffy, quite fine grained.
5	425	Layer	2	Uneven top, tunnels in the cake, dry crust on edges, uneven texture.
6	450	Layer	2	Almost burned, very uneven top, tunnels.
7	375	Cup	2	Not brown enough, too close in texture, quite fine grained.
8	400	Cup	3	Better in every way, fluffier and lighter than 7.
9	425	Cup	2	Top crust well browned. Light and fluffy, similar to 8.
10	450	Cup	2	Too brown and too hard a crust, loose texture, uneven top.
11	Cold—350	Loaf	2	Not brown enough, close compact texture.
12	350	Loaf	2	Better than 11, quite fine grained and light.
13	375	Loaf	2	Browner top, heavier crust than 12, but a very good cake.
14	400	Loaf	2	Too brown, crust cracked, texture not good.

TABLE 29.—TWO-EGG FOUNDATION BUTTER CAKE.

A Study of the Influence of the Baking Temperatures at 5,000 Feet. Atmospheric Pressure, 24.9 Inches of Mercury. Manipulation 5.

Baking powder	14 grams	Fat	98 grams
Flour	300 grams	Milk	305 grams
Salt	1 teaspoon	Egg	96 grams
Sugar	262.5 grams	Flavoring	1 teaspoon

Experiment	Baking temperature °F.	Size	Checks	Results
1	350	Layer	2	Fair, not brown enough, too compact.
2	375	Layer	4	Better, lighter and a more desirable top than 1.
3	400	Layer	7	Best of all, soft, fluffy, light, fine even grained, good crust.

TABLE 30.—Three-EGG FOUNDATION BUTTER CAKE.

A Study of the Influence of the Baking Temperatures at 5,000 Feet. Atmospheric Pressure, 24.9 Inches of Mercury. Manipulation 2.

Baking powder	12 grams	Fat	140 grams
Flour	300 grams	Milk	244 grams
Salt	1 teaspoon	Egg	144 grams
Sugar	275 grams	Flavoring	1 teaspoon

Experiment	Baking temperature °F.	Size	Checks	Results
1	Cold—350	Layer	2	Browner than 1 or 2-egg cakes but not brown enough, fair texture but not so light as 3 or 4.
2	350	Layer	2	Fair, top satisfactory, not so light as 3 or 4.
3	375	Layer	9	Very good cake, delicate brown top, even fine grained, light.
4	400	Layer	7	The best cake of the group. Light, soft and fluffy in texture.
5	425	Layer	2	Too brown a crust, uneven top, looser texture than 4.
6	375	Cup	6	Fair, quite a delicate brown, fine grained, light.
7	400	Cup	4	Very good top, thin crust, light and feathery, fine grained.
8	425	Cup	2	Fair but too thick a crust and texture, not so good as 7.
9	Cold—350	Loaf	2	Very fair product, good grain, delicate top, quite light.
10	350	Loaf	2	Similar but slightly better than 9.
11	375	Loaf	2	Slightly raised in center. Not so good and even grained as 10. Too brown on top.

TABLE 31.—Four-Egg Foundation Butter Cake.

A Study of the Influence of the Baking Temperatures at 5,000 Feet. Atmospheric Pressure, 24.9 Inches of Mercury. Manipulation 2.

Baking powder	10 grams	Fat	182 grams
Flour	300 grams	Milk	183 grams
Salt	1 teaspoon	Egg	192 grams
Sugar	300 grams	Flavoring	1 teaspoon

Experiment	Baking temperature °F.	Size	Checks	Results
1	350	Layer	2	Very fair product, not quite so good as 2 and 3, crust lighter in color, not so soft and fluffy as 2 and 3.
2	375	Layer	6	Very good cake, delicate brown top, fine grained, soft and fluffy.
3	400	Layer	4	Similar to but with crust slightly browner and thicker than 2.

TABLE 32.—Three-Egg Foundation Butter Cake.

A Study of the Influence of the Baking Temperatures at 11,180 Feet. Atmospheric Pressure, 19.9 Inches of Mercury. Manipulation 2.

Baking powder	6 grams	Fat	126 grams
Flour	300 grams	Milk	244 grams
Salt	1 teaspoon	Egg	144 grams
Sugar	225 grams	Flavoring	1 teaspoon

Experiment	Baking temperature °F.	Size	Checks	Results
1	Cold—350	Layer	2	Not brown enough, very compact.
2	350	Layer	2	Slightly better than 1.
3	375	Layer	2	Browner, lighter and better texture than 2.
4	400	Layer	4	Very good cake, soft and fluffy, fine grained, delicate brown crust.

CONCLUSION

The following conclusions are based on the above experiments on baking temperatures:

1. Starting a cake in a cold oven has no advantages over placing it in a warm oven, and in no case was the resulting cake equal in texture or delicacy of crust to those baked at a steady temperature. It has the disadvantage that the oven must be carefully watched until the temperature reaches the maximum, and even with an oven regulator the time required to reach this maximum may vary.

2. A baking period of a steady temperature is more satisfactory and much easier to standardize than one in which the temperature varies.

3. The size of the cake determines the most desirable temperature. A loaf cake, in which there is a much larger amount of material than in other forms, requires a lower temperature

and longer period of baking than does the layer cake because of the greater time required for heat to reach the center of the cake. A too high temperature bakes the outside more than is desirable and sometimes forms so hard a crust that the top cracks open under the pressure within the product and the yet uncoagulated material runs over onto the top, or at best the center is raised. Layer cakes bake best at a slightly higher temperature than that required for loaf cakes because the surface of the cake is greater and the material is spread out in a thinner layer so that the heat may penetrate it more easily. The cup cake, having the smallest volume, bakes at a still higher temperature, so that coagulation may take place before the drying out of the product.

4. The material of which the cake pan is made influences the temperature required. A thin material such as tin or aluminum serves best. Glass pans hold the heat and the temperature must be reduced or the crusts which are next to the glass will be too brown and thick and the cake will rise slightly in the center.

5. The baking temperature for the same size of cake decreases slightly with the richness of the cake. Those containing a small amount of butter and sugar will bake at a higher temperature without burning or forming thick crusts than those which contain a larger proportion of these ingredients.

6. At higher elevations and drier climates a slight increase of temperature is desirable.

The following table sums up these results:

TABLE 33.—The Optimum Baking Temperatures for the Four Types of Foundation Butter Cakes at Sea Level, at 5,000 Feet and at 11,180 Feet.

Kind of Cake	Size	Baking Temperature		
		Sea Level (29.9 inches) °F.	5,000 Feet (24.9 inches) °F.	11,180 Feet (19.9 inches) °F.
	Loaf	365	370	375
1-Egg Foundation............	Layer	390	395	400
	Cup	415	420	425
	Loaf	360	365	370
2-Egg Foundation............	Layer	385	390	395
	Cup	410	415	420
	Loaf	355	360	365
3-Egg Foundation............	Layer	380	385	390
	Cup	405	410	415
	Loaf	350	355	360
4-Egg Foundation............	Layer	375	380	385
	Cup	400	405	410

DETERMINATION OF BEST PROPORTIONS OF INGREDIENTS

The proportion of ingredients is of the greatest importance. To produce the best cake of each type one may choose a very plain or a very rich cake and each will be equally satisfactory for the purpose if the quality is excellent. A simple cake of high

TABLE 34.—One-Egg Foundation Butter Cake.

Variations in Proportions of Ingredients at Sea Level. Atmospheric Pressure, 29.9 Inches of Mercury.

Flour .... 150 grams; Salt .... ½ teaspoon; Egg .... 24 grams; Flavoring .... ½ teaspoon

Experiment	Baking powder grams	Sugar grams	Fat grams	Milk grams	Checks	Results
Tartrate Baking-Powder Group						
1	12.0	150.0	35	183.0	3	Fair texture, light brown top, too loose and coarse, too many holes.
2	12.0	150.0	35	167.8	2	Fair, some holes near top, better than 1 but a trifle heavy.
3	12.0	150.0	35	160.1	2	Similar to 2.
4	12.0	150.0	35	152.5	4	Better than 1, 2 and 3. Light and fluffy, quite fine grained, few holes.
5	12.0	150.0	28	183.0	2	Fair, but slightly tough, holes, depressed in center.
6	12.0	137.5	35	183.0	2	Not so light as 1.
7	12.0	137.5	28	183.0	2	Rather close and heavy, slightly tough.
8	12.0	137.5	35	152.5	2	Smaller and coarser than 7, more holes than 4.
9	11.0	150.0	35	183.0	4	Very few holes, otherwise good, quite fine grained, light, fluffy.
10	11.0	150.0	35	160.1	4	Fair, some holes, not quite so good as 9.
11	11.0	150.0	35	152.5	2	Not so good as 4 and 9.
12	10.0	137.5	35	183.0	2	Not so tender or light as 9, also more holes.
13	10.0	150.0	35	183.0	2	Similar to 9 but not quite so light and fluffy.
14	10.0	150.0	35	160.1	2	Similar to 13, perhaps a few more holes.
15	10.0	137.5	35	183.0	2	More holes and not so light and fluffy as 9.
S. A. S. Baking-Powder Group						
16	14.0	150.0	28	183.0	1	Very tender but coarse, loose and crumbly.
17	12.0	150.0	35	160.1	1	Fair texture, some holes, brown top.
18	11.0	150.0	35	160.1	1	Slightly finer grained, otherwise similar to 17.
19	9.0	150.0	35	183.0	2	Quite fine grained, light and fluffy.
20	9.0	150.0	35	167.8	1	Some holes, rather crumbly.
21	9.0	150.0	35	160.1	3	Some holes, reasonably fine, better than 17, 18 or 22.
22	10.0	150.0	35	160.1	1	Not so fine as 21.
23	8.3	150.0	35	183.0	3	Very good, soft, light and fluffy cake, fine grained, similar to 19.
24	8.3	150.0	35	167.8	1	More holes and not so fine grained as 19 or 23.
25	8.0	150.0	35	183.0	4	Best of this group tho very similar to 23. Soft, tender, fluffy cake.
26	8.0	150.0	35	160.1	3	Good, but not equal to 25, more holes.

standard is far superior to a rich cake, poor in texture and flavor. The proportions depend upon the kind of cake desired and the altitude at which it is to be baked.

The weights of ingredients are given in grams: Butter and milk were the fat and liquid chosen. The three kinds of baking powder were tried out and it was found that the tartrate and phosphate powders gave similar results. Therefore, the experiments reported below are with tartrate and with sodium-aluminum-sulphate powders as indicated. The flours used were well-known brands of cake flour.

Unless otherwise indicated, the experiments to follow were with the layer cake and the proportions given in each experiment were for one layer.

TABLE 35.—TWO-EGG FOUNDATION BUTTER CAKE.

Variations in Proportions of Ingredients at Sea Level. Atmospheric Pressure, 29.9 Inches of Mercury.

Flour .... 150 grams Egg .... 48 grams
Salt .... ½ teaspoon Flavoring .... ½ teaspoon

Experiment	Baking powder grams	Sugar grams	Fat grams	Milk grams	Checks	Results
Tartrate Baking-Powder Group						
1	11.0	150.0	56	152.5	2	Fine grained, light, fluffy, very good.
2	11.0	150.0	56	137.3	4	Good, slightly coarser grained than 1 but light and fluffy, a few holes.
3	11.0	150.0	56	122.0	1	Many large holes, coarser and not so even and fine as 1.
4	11.0	150.0	63	152.5	2	Slightly coarser than 1 and more crumbly.
5	11.0	150.0	49	152.5	2	Similar to 1 but not so tender.
6	11.0	137.5	56	152.5	2	Tendency to tunnels, coarser, not so light as 1.
7	11.0	131.3	56	152.5	1	Coarser and more holes than 6, rather soft.
8	11.0	131.3	56	132.0	1	Slightly finer than 7.
9	10.0	150.0	56	152.5	4	Exceptionally good, similar to 1 but slightly finer and softer.
10	10.0	150.0	56	137.3	2	Not so high, light and fluffy, a few holes.
11	9.0	162.5	56	152.5	1	High and light, too coarse, many holes.
12	9.0	150.0	56	152.5	5	A very few holes, light and fluffy but not quite equal to 9.
13	9.0	150.0	56	137.3	3	Holes, not so good as 12.
14	9.0	150.0	56	122.0	2	Finer than 13 but drier and more compact, not light.
15	8.0	150.0	56	152.5	1	Similar to 12, not so light and fluffy.
16	7.0	150.0	56	152.5	1	Slightly heavier and more compact.
S. A. S. Baking-Powder Group						
17	9.8	150.0	56	152.5	1	Crumbly, too loose.
18	9.0	150.0	56	152.5	1	Similar to 19 but with a few more holes and slightly coarser.
19	8.3	150.0	56	152.5	2	Very fine grained, soft, light and fluffy.
20	7.5	150.0	56	152.5	6	Fine grained, similar to 19.
21	7.5	150.0	56	137.3	2	Not so good as 20, more holes.
22	7.0	150.0	56	152.5	4	Fine grained, soft, fluffy, not quite so light as 19 and 20.
23	6.8	150.0	56	152.5	3	Similar to 12, a few holes.

TABLE 36.—Three-Egg Foundation Butter Cake.

Variations in Proportions of Ingredients at Sea Level. Atmospheric Pressure, 29.9 Inches of Mercury.

Flour	150 grams	Egg	72 grams
Salt	½ teaspoon	Flavoring	½ teaspoon

Experiment	Baking powder grams	Sugar grams	Fat grams	Milk grams	Checks	Results
Tartrate Baking-Powder Group						
1	10.0	175.0	84.0	122.0	2	Sugary crust, lighter than 6.
2	10.0	162.5	84.0	122.0	2	Fine grained but not so light and fluffy as 3.
3	10.0	162.5	77.0	122.0	6	Best of 1-6. Light, fluffy, tender.
4	10.0	162.5	77.0	114.4	4	Fair, quite fine grained but with more holes and not so high and light as 3.
5	10.0	162.5	77.0	112.0	2	Fine grained but too compact.
6	10.0	150.0	84.0	122.0	3	More compact, not so light, soft and fluffy as 1.
7	9.0	162.5	87.5	122.0	2	Slightly better than 6.
8	9.0	162.5	84.0	122.0	2	Slightly better than 6.
9	9.0	162.5	77.0	122.0	5	Finer grained than 3, light, fluffy, tender, no holes, very good.
10	9.0	162.5	77.0	114.4	3	Not so soft and fluffy as 9, otherwise very good, fine grained.
11	9.0	150.0	84.0	122.0	2	Fine grained but not so soft, light and fluffy as 9.
12	9.0	150.0	77.0	122.0	2	Slightly coarser and not so light and tender as 9.
13	8.0	162.5	77.0	122.0	2	Fine grained, light and tender but not so fluffy as 9.
14	8.0	162.5	77.0	114.4	2	Similar to 13 but with a few holes.
15	6.0	150.0	56.3	122.0	2	Very pale and compact.
S. A. S. Baking-Powder Group						
16	10.0	175.0	84.0	122.0	1	Feathery, loose, fluffy.
17	10.0	150.0	84.0	122.0	1	Fine grained, a few holes, fluffy, loose, soft.
18	8.0	175.0	84.0	122.0	2	Quite fine grained, fluffy.
19	8.0	150.0	84.0	122.0	1	Coarser and not so light as 18.
20	7.5	162.5	77.0	114.4	2	Not so fine grained and even as 21.
21	7.0	162.5	77.0	122.0	5	Similar to 23.
22	7.0	162.5	77.0	114.4	2	More holes, not so light and fluffy as 21.
23	6.8	162.5	77.0	122.0	6	Best of this group, very good, fluffy, light, fine, soft.
24	6.8	162.5	77.0	114.4	3	Similar to 21 but with a few holes.
25	6.0	162.5	77.0	122.0	3	Fine grained, but not quite so light, soft and fluffy as 21 or 23.

TABLE 37.—FOUR-EGG FOUNDATION BUTTER CAKE.

Variations in Proportions of Ingredients at Sea Level. Atmospheric Pressure, 29.9 Inches of Mercury.

Flour	150 grams	Egg	96 grams
Salt	½ teaspoon	Flavoring	½ teaspoon

Experiment	Baking powder grams	Sugar grams	Fat grams	Milk grams	Checks	Results
Tartrate Baking-Powder Group						
1	9.0	200.0	112.5	122.0	1	Moist, heavy, soggy layer on bottom, sugary crust.
2	9.0	200.0	112.5	91.5	2	Much better than 1 but still slightly coarse and heavy, sugary crust.
3	9.0	175.0	98.0	91.5	7	Fine grained, light, fluffy, slightly coarser than 6.
4	9.0	175.0	98.0	106.8	2	Not so light and fluffy as 3.
5	8.2	200.0	112.5	91.5	2	Slightly heavy, slightly coarse, sugary crust.
6	8.0	175.0	98.0	91.5	5	Tender, light, fluffy, soft. Fine even grained, best of this group.
7	8.0	175.0	98.0	106.8	2	Not so fine or light as 6.
8	7.0	175.0	98.0	91.5	4	Finer grained than others of this group but slightly compact.
9	7.5	168.8	87.5	106.8	1	Not so fine, light, tender and soft as 8.
S. A. S. Baking-Powder Group						
10	8.0	175.0	112.5	91.5	1	Fair, slightly coarse and slightly heavy.
11	7.0	200.0	112.5	91.5	1	Quite fine grained, soft and light.
12	7.0	200.0	105.3	91.5	2	Slightly higher and fluffier than 11, tender, fine grained.
13	7.0	200.0	98.0	91.5	2	Good but not so light as 15.
14	7.0	175.0	112.5	91.5	2	Similar to 11 but slightly finer.
15	6.0	175.0	98.0	91.5	2	Very good, fine grained, soft, fluffy, tender, good crust.
16	6.8	175.0	98.0	91.5	4	Almost as fine grained as 15.
17	5.3	175.0	98.0	91.5	5	Similar to 15 but slightly too compact.

TABLE 38.—BEST FOUNDATION BUTTER CAKES AT SEA LEVEL.

Atmospheric Pressure, 29.9 Inches of Mercury.
Full Recipe.

	Baking powder grams	Flour grams	Salt teaspoon	Sugar grams	Fat grams	Milk grams	Egg grams	Flavoring teaspoon	Type
Tartrate or S.A.S.									
22	16.5	300	1	300	70	366	48	1	1-egg foundation
20	15.0	300	1	300	112	305	96	1	2-egg foundation
18	13.5	300	1	325	154	244	144	1	3-egg foundation
16	12.0	300	1	350	196	183	192	1	4-egg foundation

TABLE 39.—One-Egg Foundation Butter Cake.

Variations in Proportions of Ingredients at 5,000 Feet. Atmospheric Pressure, 24.9 Inches of Mercury.

Flour	150 grams	Egg	24 grams
Salt	½ teaspoon	Flavoring	½ teaspoon

Experiment	Baking powder grams	Sugar grams	Fat grams	Milk grams	Checks	Results
Tartrate Baking-Powder Group						
1	12.0	150.0	28	213.0	1	Very coarse, heavy, not done, fell.
2	12.0	150.0	28	183.0	1	Coarse, very heavy, rose slightly.
3	11.4	150.0	28	183.0	1	Same as 2, heavy and soggy.
4	10.5	150.0	28	183.0	2	Similar to 3 but a trifle better.
5	9.3	150.0	28	213.0	1	Same as 4, rose slightly.
6	9.3	150.0	28	183.0	1	Coarse, heavy, fallen.
7	9.3	150.0	28	152.5	1	Slightly better than 6.
8	8.0	150.0	28	183.0	2	Much better than 7 but not so good as 9
9	8.0	143.8	28	183.0	12	Fine grained, light, fluffy, tender, very good.
10	8.0	143.8	28	160.0	2	Similar to but more dry than 9. Tendency to holes.
11	8.0	137.5	28	183.0	2	Paler, not so light, soft, fluffy and fine grained as 9.
12	8.0	131.3	28	183.0	2	Paler, coarser, more holes than 11.
13	8.0	131.3	28	167.8	2	Too coarse, many holes.
14	8.0	125.0	28	183.0	2	Inclined to many tunnels, very coarse.
15	7.0	150.0	28	183.0	1	Reasonably fine grained but not so good as 9.
S. A. S. Baking-Powder Group						
16	12.0	150.0	28	183.0	1	Soggy, coarse and fallen.
17	7.0	150.0	28	183.0	1	Fair product, slightly coarse.
18	7.0	143.8	28	183.0	2	Better than but not so fine grained as 9. Tender crust.
19	6.0	143.8	28	183.0	4	Best of this group, very tender, light, fluffy, quite fine grained.
20	5.0	143.8	28	183.0	2	Quite good, finer grained but not so soft as 19.
21	5.0	143.8	28	167.8	2	Not so fine grained and more holes than 20.

TABLE 40.—TWO-EGG FOUNDATION BUTTER CAKE.

Variations in Proportions of Ingredients at 5,000 Feet. Atmospheric Pressure, 24.9 Inches of Mercury.

Flour	150 grams	Egg	48 grams
Salt	½ teaspoon	Flavoring	½ teaspoon

Experiment	Baking powder grams	Sugar grams	Fat grams	Milk grams	Checks	Results
Tartrate Baking-Powder Group						
1	11.0	150.0	56	152.5	1	Coarse, heavy. Fell.
2	9.0	130.0	49	122.0	1	Fell slightly. Coarse and heavy.
3	9.0	130.0	42	152.5	2	Higher and lighter than 1 and 2 but not very fine grained.
4	9.0	130.0	42	122.0	4	Light but coarse.
5	8.5	150.0	56	122.0	1	Fell. Heavy and soggy.
6	7.2	130.0	42	122.0	1	Coarse.
7	7.0	131.3	49	152.5	8	Fine grained, light, fluffy, soft. Best of this group.
8	7.0	137.5	49	152.5	3	Fair but slightly coarse. than 7.
9	7.0	143.8	49	152.5	2	Coarser than 8, very tender, fell apart, sugary crust.
10	7.0	131.3	42	152.5	2	Light, fine, but not so feathery and tender as 7.
11	7.0	131.3	49	145.0	2	Coarser and not so soft and light as 7.
12	7.0	125.0	49	152.5	2	Quite good, fine grained but tendency to hole.
13	7.0	125.0	49	145.0	2	Coarser and not so soft and light as 12.
14	5.0	131.3	42	152.5	2	Light and fine grained but not so feathery and soft as 7.
S. A. S. Baking-Powder Group						
15	9.5	150.0	49	122.0	2	Thick crust, heavy, soggy, coarse, failure.
16	9.5	143.8	49	122.0	1	Thick crust, crumbled, coarse, not soggy.
17	6.0	150.0	56	122.0	2	Fell slightly. Tender, but not light and fluffy.
18	6.0	150.0	49	122.0	2	Fell slightly. Tender, not fine grained.
19	6.0	143.8	56	122.0	2	Fell slightly. Rich, tender, crumbly.
20	6.0	143.8	49	122.0	2	Finer grained than 15 to 19, crumbly, not light.
21	6.0	143.8	45	122.0	1	Compact, not light, tunnels, crumbly.
22	6.0	137.5	45	122.0	2	Close grained, few holes, not light.
23	6.0	137.5	42	122.0	1	About the same as 22 but slightly lighter.
24	6.0	131.3	49	122.0	2	Reasonably fine grained, inclined to crack.
25	5.2	130.0	42	122.0	1	Fine grained, tender, occasional holes.
26	5.0	143.8	45	122.0	1	Not quite so good as 21.
27	5.0	137.5	45	122.0	1	Flat top, compact, tunnels.
28	5.0	137.5	42	122.0	2	Slightly lighter than 27.
29	5.0	131.3	42	152.3	4	Fine grained, very light and fluffy, feathery, very good soft cake.
30	5.2	131.3	49	152.5	7	Similar to 29 but slightly more tender and fluffier than 29. Best of this group.

TABLE 41.—Three-Egg Foundation Butter Cake.

Variations in Proportions of Ingredients at 5,000 Feet. Atmospheric Pressure, 24.9 Inches of Mercury.

Flour	150 grams	Egg	72 grams
Salt	½ teaspoon	Flavoring	½ teaspoon

Experiment	Baking powder grams	Sugar grams	Fat grams	Milk grams	Checks	Results
Tartrate Baking-Powder Group						
1	8.0	131.3	56	122.0	2	Fine grained but slightly tough.
2	7.0	131.3	70	122.0	2	Better in every way than 1, fine grained, light and tender.
3	6.0	143.8	70	122.0	2	Coarser than 4 to 8.
4	6.0	137.5	70	122.0	6	Very good, fine grained, soft, tender, light, fluffy, good crust.
5	6.0	131.3	70	122.0	10	Similar to 4. Very good, not quite so fluffy, good crust.
6	6.0	131.3	70	114.4	3	Slightly more compact and not so soft as 4.
7	6.0	137.5	77	122.0	2	Slightly more crumbly and not so fluffy as 4.
8	5.0	137.5	70	122.0	2	Not so light and feathery as 4.
S. A. S. Baking-Powder Group						
9	7.8	150.0	84	122.0	1	Did not fall but was very coarse.
10	7.0	131.3	70	122.0	2	Quite fine grained, light, tender.
11	5.0	131.3	70	122.0	2	Very tender and light, fine grained but crumbly.
12	4.5	131.3	70	122.0	3	Much better in every way than 11.
13	4.5	137.5	70	122.0	6	Best of this group.

TABLE 42.—Four-Egg Foundation Butter Cake.

Variations in Proportions of Ingredients at 5,000 Feet. Atmospheric Pressure, 24.9 Inches of Mercury.

Flour	150 grams	Egg	96 grams
Salt	½ teaspoon	Flavoring	½ teaspoon

Experiment	Baking powder grams	Sugar grams	Fat grams	Milk grams	Checks	Results
Tartrate Baking-Powder Group						
1	9.0	200	112.5	122.0	2	Total failure, ran over, soggy.
2	5.0	200	84.5	122.0	1	Coarse, tenacious, chewy crust, heavy, soggy. Cake fell.
3	5.0	150	91.0	91.5	7	Fine grained, light, tender, fluffy. Best of this group.
4	5.0	150	99.3	91.5	2	Fine grained, soft and fluffy but not so good and light as 3.
5	4.5	150	91.0	91.5	2	Not so soft, light and fluffy as 3.
S. A. S. Baking-Powder Group						
6	9.0	200	112.5	91.5	1	Fell completely, ran over, soggy.
7	6.0	174	91.0	122.0	2	Sugary crust, not fine grained, very tender, light, fell apart.
8	6.0	150	77.0	122.0	2	Not rich, tender or light enough.
9	3.7	150	91.0	91.5	6	Exceptionally good, very fine grained, moist and tender, light, fluffy.

TABLE 43.—BEST FOUNDATION BUTTER CAKES AT 5,000 FEET.

Atmospheric Pressure, 24.9 Inches of Mercury.
Full Recipe.

Baking powder grams		Flour grams	Salt teaspoon	Sugar grams	Fat grams	Milk grams	Egg grams	Flavoring teaspoon	Type
Tartrate or S.A.S.									
16	12.0	300	1	287.5	56	366	48	1	1-egg foundation
14	10.5	300	1	262.5	98	305	96	1	2-egg foundation
12	9.0	300	1	275.0	140	244	144	1	3-egg foundation
10	7.5	300	1	300.0	182	183	192	1	4-egg foundation

TABLE 44.—ONE-EGG FOUNDATION BUTTER CAKE.

Variations in Proportions of Ingredients at 11,180 Feet. Atmospheric Pressure, 19.9 Inches of Mercury.

Flour	150 grams	Egg	24 grams
Salt	½ teaspoon	Flavoring	½ teaspoon

Experiment	Baking powder grams	Sugar grams	Fat grams	Milk grams	Checks	Results
Tartrate Baking-Powder Group						
1	11.0	150.0	35	183.0	1	Fell completely. Sugary, soggy mass.
2	5.0	137.5	21	205.9	1	Very coarse, moist and soggy.
3	5.0	137.5	21	183.0	1	Slightly better but very similar to 2.
4*	5.0	125.0	21	183.0	6	Soft, light and quite fine grained, very few small holes.
5	4.0	137.5	21	205.9	1	Better than 1, 2 and 3, but too moist and soggy.
6	4.0	137.5	21	183.0	1	Less moist, and finer than 5, but still too coarse and heavy.
7	4.0	125.0	21	190.6	2	Too loose and coarse.
8*	4.0	125.0	21	183.0	3	Quite fine grained, slightly moist but light and tender.
9	4.0	125.0	21	175.4	2	Very poor, holes.
10	4.0	125.0	21	167.8	1	More holes than 9.
11	4.0	112.5	21	183.0	2	Coarser and more holes than 8.
12	3.5	125.0	21	175.4	2	Not so good as 15 but better than 9.
13	3.0	137.5	21	183.0	2	Fairly fine grained, and somewhat moist.
14	3.0	125.0	21	190.6	1	Coarse, many holes.
15*	3.0	125.0	21	183.0	2	Slightly finer but not so light and fluffy as 4.

*Very difficult to decide on 4, 8 and 15. Manipulation very important.

TABLE 45.—TWO-EGG FOUNDATION BUTTER CAKE.

Variations in Proportions of Ingredients at 11,180 Feet. Atmospheric Pressure, 19.9 Inches of Mercury.

Flour	150 grams	Egg	48 grams
Salt	½ teaspoon	Flavoring	½ teaspoon

Experiment	Baking powder grams	Sugar grams	Fat grams	Milk grams	Checks	Results
Tartrate Baking-Powder Group						
1	10.0	150.0	56	152.5	1	Fell completely.
2	5.0	112.5	42	167.8	1	Coarser than 3.
3	5.0	112.5	42	152.5	2	Smooth top, slightly fallen, very loose texture.
4	4.0	112.5	42	167.8	2	Slightly finer than 1 to 3 but coarser than 5.
5	4.0	112.5	42	152.5	4	Light, tender, soft and fluffy.
6	4.0	112.5	42	144.9	2	Coarser than 5.
7	4.0	106.3	42	152.5	2	Similar to 6.
8	3.0	125.0	42	152.5	2	Fair, better than 11.
9	3.0	118.8	42	152.5	1	Not so fine grained as 8.
10	3.0	112.5	42	159.0	2	Pale crust, reasonably fine grained.
11	3.0	112.5	42	152.5	2	Coarser than 10, tunnels.
12	3.0	112.5	42	144.9	1	Coarse, many holes.
13	3.0	106.3	42	132.5	2	Fair, light and tender but with tunnels.
14	2.5	112.5	42	159.0	1	Quite fine grained, but not so light as 5. Pale crust.
15	2.5	112.5	42	152.5	2	Very pale crust, quite fine grained, not so light as 5.
16	2.0	112.5	42	152.5	2	Very pale crust, finest in grain of this group but not very light.
17	2.0	112.5	42	144.4	2	Softer and finer than 16.
S. A. S. Baking-Powder Group						
18	2.3	112.5	42	159.0	2	Slightly too loose in texture.
19	3.0	112.5	42	152.5	4	Light, fluffy, even texture, quite fine grained, best of this group.

TABLE 46.—Three-Egg Foundation Butter Cake.

Variations in Proportions of Ingredients at 11,180 Feet. Atmospheric Pressure, 19.9 Inches of Mercury.

Flour	150 grams	Egg	72 grams
Salt	½ teaspoon	Flavoring	½ teaspoon

Experiment	Baking powder grams	Sugar grams	Fat grams	Milk grams	Checks	Results
Tartrate Baking-Powder Group						
1	9.0	162.5	77	122.0	1	Fell completely.
2	3.0	118.8	63	129.6	2	Slightly too loose, fine grained, light.
3	3.0	118.8	63	122.0	4	Best of this group, fine grained, light, fluffy.
4	3.0	112.5	62	129.6	3	Good, light, fluffy, fine grained, few holes, not quite so good as 3.
5	3.0	112.5	63	122.0	2	Similar to but slightly less light and fluffier than 3.
6	3.0	112.5	63	114.4	2	Coarser than 5.
7	2.5	118.8	63	122.0	2	Similar to but not quite so good as 3.
8	2.0	125.0	63	129.6	2	Coarser and more holes than 3.
9	2.0	125.0	63	122.0	2	Higher, lighter, slightly coarser than 3.
10	2.0	118.8	63	129.6	2	Quite satisfactory, similar to 3.
11	2.0	118.8	63	122.0	2	Similar to but not quite so light and fine grained as 3.
12	2.0	112.5	63	129.6	2	Fair, but coarser and not so light and fluffy as 3.
13	2.0	112.5	63	122.0	2	Not so light and fine grained as 3.
14	1.5	125.0	63	129.6	2	Coarser than 3.
15	1.5	118.8	63	129.6	2	More holes and not so light as 3.
16	1.5	112.5	63	129.6	3	Quite fine grained but not so light and fluffy as 3.
17	1.5	112.5	63	122.0	3	Similar to 16.
18	1.5	112.5	70	129.6	2	Slightly coarser than 17, inclined to crumble.
19	1.5	112.5	56	129.6	2	Tougher than 16.
20	1.5	106.3	63	129.6	2	Fine grained but not light.
21	1.0	125.0	63	122.0	3	Finer grained than others of group but too compact.
S. A. S. Baking-Powder Group						
22	3.0	118.8	63	122.0	1	Fair but slightly too coarse and loose.
23	2.3	118.8	63	122.0	4	Very good, fluffy, light, fine grained, soft. Similar to 3.

TABLE 47.—FOUR-EGG FOUNDATION BUTTER CAKE.

Variations in Proportions of Ingredients at 11,180 Feet. Atmospheric Pressure, 19.9 Inches of Mercury.

Flour	150 grams	Egg	96 grams
Salt	½ teaspoon	Flavoring	½ teaspoon

Experiment	Baking powder grams	Sugar grams	Fat grams	Milk grams	Checks	Results
Tartrate Baking-Powder Group						
1	2.0	131.3	84	91.5	1	Coarser than 3.
2	2.0	125.0	84	122.0	1	Too moist and heavy.
3	2.0	125.0	84	91.5	3	Good, fine grained, light, fluffy, best of this group.
4	1.5	125.0	84	91.5	2	Fair, but not so fluffy as 3.
5	1.0	137.5	84	91.5	2	Too coarse, cake fell in center.
6	1.0	131.3	84	91.5	1	Coarser than 3 but better than 5.
7	1.0	125.0	84	122.0	1	Too moist, heavy.
8	1.0	125.0	84	91.5	2	Fine grained but not so light and fluffy as 3.
9	1.0	131.3	77	98.0	1	Similar to 6.
10	1.0	125.0	77	91.5	1	Fair.
11	1.0	118.8	77	98.0	2	Fine grained but not so light and tender as 3.
12	1.0	118.8	77	91.5	2	Better than 11.
S. A. S. Baking-Powder Group						
13	1.8	125.0	84	91.5	3	Very satisfactory, best of the group.
14	1.5	137.5	84	91.5	2	Slightly coarser than 13.
15	1.0	125.0	84	107.0	2	Not so fine grained and light as 13.

TABLE 48.—BEST FOUNDATION BUTTER CAKES AT 11,180 FEET.

Atmospheric Pressure, 19.9 Inches of Mercury.
Full Recipe.

Baking powder grams		Flour grams	Salt teaspoon	Sugar grams	Fat grams	Milk grams	Egg grams	Flavoring teaspoon	Type
Tartrate or S.A.S.									
10	7.5	300	1	250.0	42	366	48	1	1-egg foundation
8	6.0	300	1	225.0	84	305	96	1	2-egg foundation
6	4.5	300	1	237.5	126	244	144	1	3-egg foundation
4	3.0	300	1	250.0	168	183	192	1	4-egg foundation

SUMMARIES OF BEST RECIPES FOR RANGES OF ALTITUDES BETWEEN SEA LEVEL AND 15,500 FEET

The majority of the baking experiments were carried on at sea level, 5,000 feet, and at 11,180 feet. A sufficient number of experiments were completed at 3,000 feet, at 6,200 feet and at 7,300 feet to establish the proportions of ingredients given in the tables and to make it possible to arrive at the remaining values given in Tables 49, 50, 51 and 52 by interpolation.

Then the values given for each elevation were carefully checked.

TABLE 49.—One-Egg Foundation Butter Cake.

Proportions of Ingredients for the Range in Altitudes Between Sea Level and 15,500 Feet.

Flour	300 grams (3 cups)	Egg	48 grams (1)
Salt	1 teaspoon	Milk	366 grams (1½ cups)
		Flavoring	1 teaspoon

Atmospheric pressure inches	Altitude feet	Baking powder Tartrate grams	or S. A. S. grams	Butter grams	Sugar grams
29.9	Sea level	22.0	16.5	70.0	300.0
		5¾ t.	4⅛ t.	5 T.	1½ c.
28.9	1,018	21.0	15.8	67.2	297.5
		5½ t.	3⅞ t.	5 T. — ½ t.	1½ c. — ½ t.
27.9	1,997	19.9	14.9	64.4	295.0
		5⅛ t.	3¾ t.	5 T. — 1¼ t.	1½ c. — 1¼ t
26.9	3,000	18.7	14.0	61.6	292.5
		4⅞ t.	3½ t.	4 T. + 1¼ t.	1½ c. — 2 t.
25.9	4,004	17.4	13.0	58.8	290.0
		4½ t.	3¼ t.	4 T. + ½ t.	1½ c. — 2½ t.
24.9	5,000	16.0	12.0	56.0	287.5
		4⅛ t.	3 t.	4 T.	1½ c. — 1 T.
23.9	6,200	14.6	11.0	53.2	280.0
		3¾ t.	2¾ t.	4 T. — ½ t.	1½ c. — 1⅓ T.
22.9	7,360	13.1	9.8	50.4	272.5
		3⅜ t.	2½ t.	4 T. — 1¼ t.	1⅜ c. — ½ t.
21.9	8,500	11.6	8.7	47.6	265.0
		3 t.	2⅛ t.	3 T. + 1¼ t.	1⅜ c. — 1½ t.
20.9	9,820	10.1	7.6	44.8	257.5
		2⅝ t.	1⅞ t.	3 T. + ½ t.	1¼ c. + 1¾ t.
19.9	11,180	8.5	6.4	42.0	250.0
		2¼ t.	1⅝ t.	3 T.	1¼ c.
18.9	12,500	6.9	5.2	39.2	242.5
		1¾ t.	1¼ t.	3 T. — ½ t.	1¼ c. — 1¾ t.
17.9	14,000	5.3	4.0	36.4	235.0
		1⅜ t.	1 t.	3 T. — 1¼ t.	1¼ c. — 1⅓ T.
16.9	15,500	3.6	2.7	33.6	227.5
		1 t.	⅝ t.	2 T. + 1¼ t.	1⅛ c. + ½ t.

TABLE 50.—TWO-EGG FOUNDATION BUTTER CAKE.

Proportions of Ingredients for the Range in Altitudes Between Sea Level and 15,500 Feet.

Flour	300 grams (3 cups)	Egg	96 grams (2)
Salt	1 teaspoon	Milk	305 grams (1¼ cups)
		Flavoring	1 teaspoon

Atmospheric pressure inches	Altitude feet	Baking powder Tartrate grams	or S. A. S. grams	Butter grams	Sugar grams
29.9	Sea level	20.0	15.0	112.0	300.0
		5¼ t.	3¾ t.	½ c.	1½ c.
28.9	1,018	19.0	14.2	109.2	292.5
		5 t.	3½ t.	½ c. — ½ t.	1½ c. — 2 t.
27.9	1,977	17.9	13.4	106.4	285.0
		4⅝ t.	3⅜ t.	½ c. — 1¼ t.	1⅜ c. + 2½ t.
26.9	3,000	16.7	12.5	103.6	277.5
		4⅜ t.	3⅛ t.	7 T. + 1¼ t.	1⅜ c. + ½ t.
25.9	4,004	15.4	11.5	100.8	270.0
		4 t.	2⅞ t.	7 T. + ½ t.	1⅜ c. — 1¼ t.
24.9	5,000	14.0	10.5	98.0	262.5
		3⅝ t.	2⅝ t.	7 T.	1⅜ c. — 1 T.
23.9	6,200	12.6	9.45	95.2	255.0
		3¼ t.	2⅜ t.	7 T. — ½ t.	1¼ c. + 1¼ t.
22.9	7,360	11.1	8.37	92.4	247.5
		2⅞ t.	2⅛ t.	7 T. — 1¼ t.	1¼ c. — ½ t.
21.9	8,500	9.6	7.2	89.6	240.0
		2½ t.	1¾ t.	6 T. + 1¼ t.	1¼ c. — 2½ t.
20.9	9,820	8.1	6.1	86.8	232.5
		2⅛ t.	1½ t.	6 T. + ½ t.	1⅛ c. + 1¾ t.
19.9	11,180	6.5	4.9	84.0	225.0
		1¾ t.	1¼ t.	6 T.	1⅛ c.
18.9	12,500	4.9	3.7	81.2	217.5
		1¼ t.	⅞ t.	6 T. — ½ t.	1⅛ c. — 1¾ t.
17.9	14,400	3.3	2.5	78.4	210.00
		⅞ t.	½ t.	6 T. — 1¼ t.	1 c. + 2½ t.
16.9	15,500	1.6	1.2	75.6	202.5
		⅜ t.	¼ t.	5 T. + 1¼ t.	1 c. + ½ t.

TABLE 51.—Three-Egg Foundation Butter Cake.

Proportions of Ingredients for the Range of Altitudes Between Sea Level and 15,500 Feet.

Flour	300 grams (3 cups)	Egg	144 grams (3)
Salt	1 teaspoon	Milk	244 grams (1 cup)
		Flavoring	1 teaspoon

Atmospheric pressure inches	Altitude feet	Baking powder Tartrate grams	or S. A. S. grams	Butter grams	Sugar grams
29.9	Sea level	18.0	13.5	154.0	325.0
		4¾ t.	3⅜ t.	11 T.	1⅝ c.
28.9	1,018	17.0	12.75	151.2	315.0
		4½ t.	3⅛ t.	11 T. -- ½ t.	1⅝ c. — 2½ t.
27.9	1,977	15.9	11.9	148.4	305.0
		4⅛ t.	3 t.	11 T. — 1¼ t.	1½ c. + 1¾ t.
26.9	3,000	14.7	11.0	145.6	295.0
		3⅞ t.	2¾ t.	10 T. + 1¼ t.	1½ c. — 1¼ t.
25.9	4,004	13.4	10.0	142.8	285.0
		3½ t.	2½ t.	10 T. + ½ t.	1⅜ c. + 2½ t.
24.9	5,000	12.0	9.0	140.0	275.0
		3⅛ t.	2¼ t.	10 T.	1⅜ c.
23.9	6,200	10.6	7.95	137.2	267.5
		2¾ t.	2 t.	10 T. — ½ t.	1⅜ c. — 1¾ t.
22.9	7,360	9.1	6.8	134.4	260.0
		2⅜ t.	1¾ t.	10 T. — 1¼ t.	1¼ c. + 2½ t.
21.9	8,500	7.6	5.7	131.6	253.5
		2 t.	1⅜ t.	9 T. + 1¼ t.	1¼ c. + ¾ t.
20.9	9,820	6.1	4.6	128.8	244.0
		1⅝ t.	1⅛ t.	9 T. + ½ t.	1¼ c. — ½ T.
19.9	11,180	4.5	3.4	126.0	237.5
		1¼ t.	⅞ t.	9 T.	1¼ c. — 1 T.
18.9	12,500	2.9	2.2	123.2	230.0
		¾ t.	⅝ t.	9 T. — ½ t.	1⅛ c. + 1¼ t.
17.9	14,000	1.3	1.0	120.4	222.5
		⅜ t.	¼ t.	9 T. — 1¼ t.	1⅛ c. — ½ t.
16.9	15,500	none	none	117.6	215.0
				8 T. + 1¼ t.	1⅛ c. — 2½ t.

TABLE 52.—FOUR-EGG FOUNDATION BUTTER CAKE.

Proportions of Ingredients for the Range in Altitudes Between Sea Level and 15,500 Feet.

Flour..........300 grams (3 cups)	Egg..........196 grams (4)
Salt.......... 1 teaspoon	Milk..........183 grams (3/4 cup)
	Flavoring.......... 1 teaspoon

Atmospheric pressure inches	Altitude feet	Baking powder Tartrate grams	or S. A. S. grams	Butter grams	Sugar grams
29.9	Sea level	16.0 4 1/8 t.	12.0 3 t.	196.0 14 T.	350 1 3/4 c.
28.9	1,018	15.0 3 7/8 t.	11.2 2 3/4 t.	193.2 14 T. — 1/2 t.	340 1 3/4 c. — 2 1/2 t.
27.9	1,977	13.9 3 5/8 t.	10.3 2 5/8 t.	190.4 14 T. — 1 1/4 t.	330 1 5/8 c. + 1 1/4 t.
26.9	3,000	12.7 3 1/4 t.	9.5 2 3/8 t.	187.6 13 T. + 1 1/4 t.	320 1 5/8 c. — 1 1/4 t.
25.9	4,004	11.4 3 t.	8.6 2 1/8 t.	184.8 13 T. + 1/2 t.	310 1 1/2 c. + 2 1/2 t.
24.9	5,000	10.0 2 5/8 t.	7.5 1 7/8 t.	182.0 13 T.	300 1 1/2 c.
23.9	6,200	8.6 2 1/4 t.	6.5 1 5/8 t.	179.2 13 T. — 1/2 t.	290 1 1/2 c. — 2 1/2 t.
22.9	7,360	7.1 1 7/8 t.	5.4 1 3/8 t.	176.4 13 T. — 1 1/4 t.	280 1 3/8 c. + 1 1/4 t.
21.9	8,500	5.6 1 1/2 t.	4.2 1 t.	173.6 12 T. + 1 1/4 t.	270 1 3/8 c. — 1 1/4 t.
20.9	9,820	4.1 1 1/8 t.	3.1 3/4 t.	170.8 12 T. + 1/2 t.	260 1 1/4 c. + 2 1/2 t.
19.9	11,180	2.5 5/8 t.	1.9 1/2 t.	168.0 12 T.	250 1 1/4 c.
18.9	12,500	0.9 1/4 t.	0.7 1/8 t.	165.2 12 T. — 1/2 t.	240 1 1/4 c. — 2 1/2 t.
17.9	14,000	none	none	162.4 12 T. — 1 1/4 t.	230 1 1/8 c. + 1 1/4 t.
16.9	15,500	none	none	159.6 11 T. + 1 1/4 t.	220 1 1/8 c. — 1 1/4 t.

VARIATIONS IN FOUNDATION BUTTER CAKES

When the recipes for the many kinds of cakes which find favor in the household, such as spice, chocolate, gold and white, are analyzed it is usually found that they are just variations of some foundation butter cake. Having established formulas for foundation butter cakes from simple to rich, the following variations were computed and tested. The principle upon which the computation was made was that the final cake should contain approximately the same proportion of protein, fat, carbohydrate and water as the foundation cake. Thus the chemical composition of each food substance was taken into consideration when it was substituted in a foundation recipe. This composition of foods varies slightly, but the following tables give accepted values. The substitution according to the composition, of course, can be only approximate, for practical use.

TABLE 53.—COMPOSITION OF CAKE INGREDIENTS IN PERCENTAGES.[21,22]

Food	Water*	Protein	Fat	Carbohydrate
Flour—family	12.42	10.84	1.09	74.99
pastry	12.48	7.58	0.80	78.23
Sugar	....	....	....	100.00
Butter	11.57	0.95	84.70	....
Crisco	....	....	100.00	....
Snowdrift	....	....	100.00	....
Oleomargarines	?	?	85.00 approx.	....
Egg-white	86.20	12.30	0.20	....
Egg-yolk	49.50	15.70	33.20	....
Whole milk	87.00	3.30	4.00	5.00
Skimmilk	90.00	3.40	0.30	5.10
Cream	74.00	2.50	18.50	4.50
Condensed sweetened	....	8.80	8.30	54.10
Chocolate—bitter	2.72	12.12	50.12	27.64

*These values are not given but are the approximations of the sum of the other components subtracted from 100.

TABLE 54.—COMPOSITION OF CAKE INGREDIENTS IN GRAMS PER UNIT MEASURE.

Food	Measure	Weight	Protein	Fat	Carbohydrate	Water
Flour—family	1 c.	113.00	12.25	1.23	84.74	14.03
—cake	1 c.	100.00	7.58	0.80	78.23	12.48
Sugar	1 c.	200.00	....	....	200.00	....
Butter	1 c.	225.00	2.13	190.57	....	26.03
Butter	1 T.	14.00	0.13	11.86	....	1.62
Oleomargarines*						
Snowdrift and	1 c.	200.00	....	200.00	....	....
Crisco, etc.	1 T.	12.50	....	12.50	....	....
Egg-white	1	30.00	3.69	0.06	....	25.86
Egg-yolk	1	18.00	2.83	5.98	....	8.91
Whole milk	1 c.	244.00	8.05	9.76	12.20	212.28
Whole milk	1 T.	15.50	0.50	0.61	0.76	13.27
Cream	1 c.	239.00	0.60	44.40	10.80	176.86
Chocolate—bitter	1 sq.	28.35	3.44	14.22	7.84	0.77

*These vary with each brand but are similar to butter.

1. VARIATIONS IN LIQUIDS.—*a. Sour Milk.*—In the foundation butter cakes the carbon dioxide is produced from the baking powder in the presence of moisture and heat. When sour milk is substituted for sweet, the lactic acid in the former will react directly with soda to produce carbon dioxide. The correct amount of soda to use is the amount which will exactly neutralize the acid of the milk. Sometimes this amount will produce sufficient carbon dioxide to leaven the product, but often, if the amount of sour milk is small, baking powder is added to produce the additional gas required.

Since the term "sour milk" is one which is applied to any milk which has a sour taste, there are two variables to take into consideration, the physical state and the degree of acidity. Milk does not change appreciably in viscosity when it begins to sour, but on standing its viscosity increases. Thus the quantity of sour milk required to give the desired consistency to a batter varies and it is necessary to state what kind of sour milk is used. As the acidity varies the amount of soda required will also vary. A means of standardization has been developed[23] of value for accurate laboratory work, but it is rather impractical for the average housewife. In the following experiments the best results were obtained with milk which was in the solid state (clabbered) and which had not become watery. The quantity of milk and of soda given is on this basis. A very thick buttermilk may be substituted for the sour milk.

To avoid repetition these experiments are given under spice cakes, but each recipe may be followed, omitting the spice.

b. Evaporated and Powdered Milks.—These should be diluted according to the directions on the can so that they are equivalent to whole milk and then substituted by volume.

c. Sweetened Condensed Milk.—Sweetened condensed milk, after dilution, may also be substituted for the whole by volume but the amount of sugar must be reduced according to the amount in the milk used.

d. Cream.—Cream may be used in place of milk. The shortening must be reduced to make allowance for the fat in the cream.

e. Water.—When water is used instead of milk slightly less than 1 cup of water should be substituted for each cup of milk, because about 87 percent of milk is water.

f. Fruit Juices.—These may be used as the liquid. They should be used in the same quantity as water but the amount of sugar added should be reduced to make allowance for the amount of sugar in the fruit juice.

2. VARIATION OF SUGAR.—Powdered or brown sugar may be substituted for the granulated sugar in the above recipes. Table 1 gives the relative proportions which may be summed up thus:

1 cup granulated = 1 cup solidly packed brown
= 2 cups lightly sifted powdered.

Brown sugar is very desirable for all or part of the sugar in chocolate and spice cakes.

3. VARIATION IN SHORTENING.—The common vegetable shortenings or oleomargarines may be substituted for the butter in the foundation cakes if the substitution is made on the basis of weight and fat content. The 100 percent fats should be sub-

stituted as 85 percent of the weight of the butter. Since these fats weigh less than butter, approximately 89 percent, for practical purposes shortenings commonly used may be substituted volume for volume.

4. WHITE CAKES.—In white cakes only the whites of eggs are used. Referring to Table 53, it is seen that the yolk contains fat, and that while it contains protein, the protein of the egg-white is responsible for the incorporation of the air. The amount of water in the white is also much greater than that in the yolk. On the basis of this analysis, in substituting a white for a yolk, fat should be added and baking powder decreased. It would seem that the liquid could also be decreased, but in making white cakes the egg-white is beaten very stiff and some of its moisture is lost.

Since each egg-yolk contains approximately 5.66 grams of fat, the nearest quantity in measure is one-half tablespoon, so that for each egg-yolk omitted one-half tablespoon of fat is added. The white contains approximately 28.45 grams of water and the yolk approximately 8.42 grams, so that 20 grams of water is added in the extra white, but a better, fluffier cake results if the liquid is not decreased.

In the foundation butter cakes it was found that the addition of 1 egg made it possible to reduce the baking powder 2 grams for tartrate or 1½ grams for S. A. S., so that since the leavening property of the egg is chiefly in the white, the baking powder may be reduced one-fourth teaspoon for each egg-white added.

5. GOLD CAKES.—These are just the reverse of the white cakes, and egg-yolks are substituted for egg-whites. When a yolk is substituted for a white, the fat may be decreased one-half tablespoon and the liquid increased one and one-third tablespoon. One-half teaspoon of baking powder is added.

6. SPICE CAKES.—Spice may be added to the recipes given for foundation cakes. It may be sifted with the flour, or the amount of spice may be placed in a small cup, twice the volume of boiling water added, and this allowed to stand 5 minutes before adding to the fat-sugar mixture. The latter method brings out the flavor of the spice. Any proportion or amount of spice, suited to the individual taste, may be used. Two mixtures that have found favor are: a.—Equal parts of allspice, cinnamon, cloves, nutmeg and ginger, using 5 teaspoons of the mixture to 3 cups of flour; b.—Two parts of cinnamon, 1 part each of cloves, allspice and nutmeg, using 5 teaspoons of the mixture to 3 cups of flour.

Spice cakes, as a rule, are better when made with sour milk than with sweet milk. For discussion of spice cakes (see pages 107 to 113).

7. CHOCOLATE CAKES.—There are so many kinds of chocolate cake that it is impossible to give more than two varieties here—the ordinary chocolate cake and the devil's food. The latter differs from the former in that it has a reddish color and a distinctive taste.

When one merely desires to add chocolate to a foundation recipe it may be melted over hot water and added to the fat-sugar mixture. Since the chocolate contains fat and carbohydrate these should be reduced in the recipe. For each square of chocolate added, the butter is reduced one-half tablespoon and one-half to two-thirds tablespoon of milk is added.

For a devil's food cake, a slightly different method of manipulation is necessary. The fat is reduced as stated above. The chocolate is melted over hot water and one-fourth cup of boiling water added to it for each square of chocolate used. This is allowed to stand a minute, then soda is added and the mixture stirred until thick. This is added to the batter at the last and thoroly blended before being put into the pans. If the cake is made with sour milk, all of the soda allowed for the sour milk and an additional three-eighths teaspoon for each square of chocolate is required. If sweet milk is used, the baking powder is added to the flour, as usual, and just the three-eighths teaspoon of soda for the chocolate is added.

STUDIES WITH WHITE CAKES

On page 98 and pages 99 to 102 are given reasons for the variations in proportions of ingredients, suggestions as to the manipulation and baking temperatures. (See Tables 55, 56 and 57.)

SUMMARY OF DIRECTIONS FOR WHITE CAKES

A. Recipe.—The quantities of flour, salt and sugar for various altitudes are the same as given for the foundation butter cakes in Tables 49, 50, 51 and 52. The amount of baking powder used may be the same as for the foundation butter cakes or it may be decreased one-fourth teaspoon for each egg-white added. The amount of liquid may be the same as for the foundation butter cakes or it may be increased 2 teaspoons for each egg-white added. The fat is increased one-half tablespoon for each egg-white added.

B. Manipulation.—The manipulation advised for the white-cake variations of the foundation butter cakes differs only in the handling of the egg-white. This is beaten until stiff, but not dry, and is carefully folded in at the last.

C. Baking Temperature.—The baking temperatures employed correspond to those accepted for the foundation butter cakes (see page 80).

Table 55.—White Cake.—Variations in Proportions of Ingredients at Sea Level. Atmospheric Pressure, 29.9 Inches of Mercury.

Flour .... 150 grams Flavoring .... ½ teaspoon
Salt .... ½ teaspoon

Experiment	Baking powder grams	Sugar grams	Fat grams	Milk grams	Egg-white grams	Baking temperature °F.	Checks	Results
2 Egg-White Cake								
1	7.5 S. A. S.	150.0	38.5	160.1	30	375	2	Light, fluffy, fine grained, very few holes.
2	7.5 S. A. S.	150.0	38.5	183.0	30	375	2	Similar to but more moist and with fewer holes than 1.
4 Egg-White Cake								
1	10.0 Tar.	150.0	63.0	122.0	60	375	2	Fair, slightly compact and dry.
2	10.0 Tar.	150.0	56.3	137.3	60	375	3	Fine grained, light, fluffy.
3	10.0 Tar.	150.0	63.0	137.3	60	375	3	Similar to but with few more holes than 2.
4	9.0 Tar.	150.0	63.0	152.5	60	375	5	Light, even grained, fluffy, exceptionally good.
6 Egg-White Cake								
1	10.0 Tar.	162.5	87.5	122.0	90	375	2	Quite good texture.
2	10.0 Tar.	150.0	94.5	88.0	90	375	2	Fair.
3	9.0 Tar.	162.5	87.5	122.0	90	375	2	Better than 1, fine grained, light.
4	9.0 Tar.	150.0	94.5	122.0	90	375	2	Not so good as 3 but better than 2.
5	9.0 Tar.	162.5	87.5	88.0	90	375	2	Too dry and compact.
6	8.0 Tar.	162.5	87.5	122.0	90	375	6	Best of this group, very fine grained, light, fluffy and moist.
8 Egg-White Cake								
1	7.0 Tar.	175.0	98.0	91.5	120	375	3	Good, light, fluffy, Not so rich and tender as 2.
2	7.0 Tar.	175.0	112.0	91.5	120	375	4	Very light, rich, tender, fine grained.

TABLE 56.—WHITE CAKE.—Variations in Proportions of Ingredients at 5,000 Feet. Atmospheric Pressure, 24.9 Inches of Mercury.

Flour .... 150 grams
Salt .... ½ teaspoon
Flavoring .... ½ teaspoon

Experiment	Baking powder grams	Sugar grams	Fat grams	Milk grams	Egg-white grams	Baking temperature °F.	Checks	Results
2 Egg-White Cake								
1	8.0 Tar.	143.8	28.0	183.0	30	400	2	Rather tough and heavy.
2	8.0 Tar.	143.8	34.0	168.0	30	400	2	Higher and fluffier than 1 but still coarse.
3	8.0 Tar.	143.8	31.5	183.0	30	400	3	Finer grained than 2, more tender than 1, quite fair for so simple a cake.
4 Egg-White Cake								
1	7.0 Tar.	131.3	49.0	152.5	60	400	2	Fair, but not so tender as 2.
2	7.0 Tar.	131.3	56.0	152.5	60	400	4	Light, tender, fluffy, fine grained.
3	5.0 Tar.	131.3	56.0	129.0	60	400	2	Not light enough.
6 Egg-White Cake								
1	6.0 Tar.	131.3	70.0	122.0	90	400	4	Good, fine grained, light.
2	6.0 Tar.	131.3	87.0	122.0	90	400	4	Fluffier and more tender than 1, fine grained.
3	5.0 Tar.	131.3	80.5	137.3	90	400	4	Very light and fluffy.
4	4.0 Tar.	131.3	80.5	137.3	90	400	3	Fine grained, light, good.
5	4.0 Tar.	131.3	80.5	122.0	90	400	2	Not quite so high, light and fluffy as 4.
6	4.0 Tar.	137.5	80.5	137.3	90	400	5	Very light, fine grained, moist, feathery.
7	4.0 Tar.	137.5	80.5	137.3	90	375	2	Similar to 6.
8	4.0 Tar.	137.5	80.5	137.3	90	350	2	Not so high and fluffy as 6 and 7, fine grained.
9	4.0 Tar.	150.0	75.0	152.0	90	400	3	Very fine grained, more compact than 8.
8 Egg-White Cake								
1	5.0 Tar.	150.0	91.0	91.5	120	400	4	Good, fine grained, light, tender.
2	5.0 Tar.	150.0	105.0	91.5	120	400	2	Not quite fine grained and moist enough.
3	2.0 Tar.	150.0	105.0	91.5	120	400	3	Better and more moist than 1 and 2.
4	3.0 Tar.	150.0	105.0	114.4	120	400	6	Best of this group, more moist than 1 to 3, fluffy, fine grained.

TABLE 57.—WHITE CAKE.—Variations in Proportions of Ingredients at 11,180 Feet. Atmospheric Pressure, 19.9 Inches of Mercury.

Flour.......150 grams
Salt....... ½ teaspoon
Flavoring....... ½ teaspoon

Experiment	Baking powder grams	Sugar grams	Fat grams	Milk grams	Egg-white grams	Baking temperature °F.	Checks	Results
6 Egg-White Cake								
1	2.0 Tar.	118.8	73.5	122.0	90	375	2	Not so fine grained as 2 and 3.
2	2.0 Tar.	118.8	73.5	129.0	90	375	2	Finer grained, fluffier and lighter than 1.
3	2.0 Tar.	118.8	73.5	137.3	90	375	3	Best of this group.
8 Egg-White Cake								
1	1.0 Tar.	125.0	98.0	91.5	120	375	4	Very fine grained, light, fluffy.
2	1.0 Tar.	125.0	98.0	114.4	120	375	2	Very fluffy, but not so fine grained as 1.

STUDIES WITH GOLD CAKES

The basis for the substitution of egg-yolk for egg-white, variations of gold cakes, manipulation and baking temperatures are discussed on page 98 and pages 103 to 106. (See Tables 58, 59 and 60.)

SUMMARY OF DIRECTIONS FOR GOLD CAKES

Under appropriate headings appear the particular variations from the directions for foundation butter cakes.

A. *Recipe.*—The quantities of flour, salt and sugar correspond to those used in the foundation butter cakes given in Tables 49, 50, 51 and 52. The same amount of leavening may be used as in the foundation butter cake or it may be increased by one-fourth teaspoon for each egg-white omitted. The shortening is decreased by one-half tablespoon for each egg-yolk added. The liquid is increased by one and one-third tablespoon for each egg-yolk added (or egg-white omitted).

B. *Manipulation.*—The egg-yolk is beaten until thick and lemon colored, then added to the fat-sugar mixture. In other particulars the manipulation is the same as for foundation butter cakes.

C. *Baking Temperature.*—The same baking temperatures are used as for the foundation butter cakes (see page 80).

TABLE 58.—GOLD CAKE.—Variations in Proportions of Ingredients at Sea Level. Atmospheric Pressure, 29.9 Inches of Mercury.

Flour....150 grams
Salt.... ½ teaspoon
Flavoring.... ½ teaspoon

Experiment	Baking powder grams	Sugar grams	Fat grams	Milk grams	Egg-yolk grams	Baking temperature °F.	Checks	Results
1 Egg-Yolk Cake								
1	12.0 Tar.	150.0	31.5	163.5	18	375–400	2	Fair, light, tender, holes near the top.
2	12.0 Tar.	150.0	27.5	175.0	18	375–400	2	Fair, slightly dry.
3	12.0 Tar.	150.0	31.5	194.0	18	375–400	3	Very much better than 1 and 2, light and fluffy.
4	8.5 S. A. S.	150.0	31.5	171.0	18	375–400	5	Good, fine grained, light and fluffy, a few holes.
5	11.0 S. A. S.	150 0	31.5	171.0	18	375–400	2	Cake fell, very coarse.
2 Egg-Yolk Cake								
1	11.0 Tar.	150.0	49.0	175.0	36	375–400	3	Very good, fluffy.
2	11.0 Tar.	150.0	49.0	163.3	36	375–400	2	Not so good, light and fluffy as 1.
3	10.0 Tar.	150.0	49.0	175.0	36	375–400	2	Slightly more compact than 2.
4	9.0 Tar.	150.0	49.0	163.3	36	375–400	2	Quite good, not so light and fluffy as 1.
5	9.0 S. A. S.	150.0	49.0	175.0	36	375–400	2	Similar to 1.
3 Egg-Yolk Cake								
1	11.0 Tar.	162.5	66.5	149.0	54	375–400	4	Very good, light, tender and feathery.
2	10.0 Tar.	162.5	66.5	156.0	54	375–400	2	Fine grained, moist, light, not quite so good as 3.
3	10.0 Tar.	162.5	66.5	148.0	54	375–400	4	Very fluffy, and light without being too moist. Similar to 2.
4 Egg-Yolk Cake								
1	9.0 Tar.	175.0	84.0	137.0	72	375–400	4	Fine grained, light, soft, very good.

TABLE 59.—GOLD CAKE.—Variations in Proportions of Ingredients at 5,000 Feet. Atmospheric Pressure, 24.9 Inches of Mercury.

Flour........150 grams
Salt........ ½ teaspoon
Flavoring........½ teaspoon

Experiment	Baking powder or grams	Soda teaspoon	Sugar grams	Fat grams	Milk* grams	Egg-yolk grams	Baking temperature °F.	Checks	Results
1 Egg-Yolk Cake									
1	8.0 Tar.	....	143.8	24.5	194.3	18	400	3	Very fluffy and tender, quite fine grained.
2	...	⅝	143.8	24.5	⅞ c. sour milk	18	400	3	Fine grained, soft and tender.
2 Egg-Yolk Cake									
1	7.0 Tar.	....	131.3	42.0	175.0	36	400	3	Very tender, fine grained, very good.
2	....	½	131.3	42.0	¾ c. sour milk	36	400	5	Almost like sponge cake, fine, feathery.
3 Egg-Yolk Cake									
1	6.0 Tar.	....	137.5	59.5	156.0	54	375–400	4	Very fine, fluffy, tender, soft cake.
2	6.0 Tar.	....	131.3	60.0	122.0	54	375–400	2	Tunnels as in muffins, failure.
4 Egg-Yolk Cake									
1	5.0 Tar.	....	150.0	77.0	137.3	72	375–400	4	Very good, fine grained, light, tender.
2	....	¼	150.0	77.0	½ c. sour milk	72	375–400	4	Fine grained, very good.

*Sweet milk is expressed in grams.

TABLE 60.—GOLD CAKE.—Variations in Proportions of Ingredients at 11,180 Feet. Atmospheric Pressure, 19.9 Inches of Mercury.

Flour........150 grams
Salt........ ½ teaspoon
Flavoring........ ½ teaspoon

Experiment	Baking powder grams	Sugar grams	Fat grams	Milk grams	Egg-yolk grams	Baking temperature °F.	Checks	Results
1 Egg-Yolk Cake								
1	5.0 Tar.	137.5	17.5	216.8	18	375–400	2	Too light and crumbly.
2	5.0 Tar.	125.0	17.5	194.0	18	375–400	3	Very much better than 1, very fair.
2 Egg-Yolk Cake								
1	4.0 Tar.	112.5	35.0	190.3	36	375–400	2	Too light and crumbly.
2	4.0 Tar.	112.5	35.0	175.0	36	375–400	3	Very much better than 1, fine grained, light.
3 Egg-Yolk Cake								
1	3.0 Tar.	125.0	52.5	164.0	54	375–400	2	Fair.
2	3.0 Tar.	112.5	52.5	164.0	54	375–400	2	Too light.
3	3.0 Tar.	118.8	52.5	156.0	54	375–400	3	Very much better, not so light and crumbly as 2.
4	2.0 Tar.	118.8	52.5	156.0	54	375–400	3	Similar to 3.
5	2.0 Tar.	118.8	52.5	164.0	54	375–400	2	Not so good as 4.
4 Egg-Yolk Cake								
1	2.0 Tar.	125.0	70.0	175.0	72	375–400	2	Good, light, fluffy.
2	2.0 Tar.	125.0	70.0	137.0	72	375–400	4	Better, finer grained than 1, very light, fluffy.

STUDIES WITH SPICE CAKES

On page 96 and pages 97 and 98 there are discussed the handling of spice mixtures, variations in kind and quantity of liquid, manipulation and baking temperatures. (See Tables 61, 62, 63, 64, 65 and 66.)

SUMMARY OF DIRECTIONS FOR SPICE CAKES

I. SWEET-MILK SPICE CAKES.—The procedure is the same as in the foundation butter cake (see pages 74 to 75). Five teaspoons of either spice mixture are measured out for each 3 cups of flour. To this spice mixture is added 10 teaspoons of boiling water and this paste is allowed to stand a few minutes before being added to the fat-sugar-egg mixture. The addition of the boiling water to the spice brings out the flavor.

II. SOUR-MILK SPICE CAKES.—*A. Recipe.*—The same quantities of flour, salt, sugar, shortening and egg are used as in the foundation butter-cake recipes at the altitudes given in Tables 49, 50, 51 and 52. The sugar may be all white or a mixture of brown and white may be used. Or brown sugar alone may be preferred.

The amounts of liquid used for each 3 cups of flour are given herewith:

1-Egg cake	1¾ cups sour milk
2-Egg cake	1½ cups sour milk
3-Egg cake	1¼ cups sour milk
4-Egg cake	1 cup sour milk

For leavening agent, soda may be used according to Table 66. For the first six elevations this amount of soda may be cut in half and one-half the amount of baking powder called for in the foundation butter-cake recipe added.

B. Manipulation.—See sweet-milk spice cakes above.

C. Baking Temperature.—Tables 61, 62, 63, 64 and 65 show baking temperatures 25 degrees F. lower than those given for corresponding foundation butter cakes.

TABLE 61.—ONE-EGG SPICE CAKE.—Variations in Proportions of Ingredients at Sea Level, at 5,000 Feet and at 11,180 Feet.

Flour..150 grams
Egg.. 24 grams
Spices, Mixture I...............................2½ teaspoons
Salt.. ½ teaspoon

Experiment	Baking powder grams	Soda teaspoon	Sugar grams	Fat grams	Liquid* cups	Baking temperature °F.	Checks	Results
Sea Level. Atmospheric Pressure, 29.9 Inches of Mercury.								
1	....	$\frac{7}{8}$	137.5	35	$\frac{7}{8}$	400	2	Quite fair.
2	....	$\frac{7}{8}$	150.0	35	$\frac{7}{8}$	350–375	4	Much better than 1.
5,000 Feet. Atmospheric Pressure, 24.9 Inches of Mercury.								
1	....	$\frac{7}{8}$	143.8	28	$\frac{7}{8}$	375–400	2	Fine grained, light, fluffy.
2	....	$\frac{3}{4}$	143.8	28	$\frac{7}{8}$	375–400	2	Similar to 1, few holes.
3	....	$\frac{5}{8}$	143.8	28	$\frac{7}{8}$	375–400	5	Best of this group, very light and fluffy, no holes.
11,180 Feet. Atmospheric Pressure, 19.9 Inches of Mercury.								
1	....	$\frac{1}{2}$	112.5	21	$\frac{7}{8}$	350	2	Too high, loose, coarse
2	....	$\frac{1}{3}$	112.5	21	$\frac{7}{8}$	350	2	Few holes, but otherwise fair.
3	....	$\frac{1}{2}$	125.0	21	$\frac{7}{8}$	350–375	3	Better than 2.

*Sour milk.

TABLE 62.—TWO-EGG SPICE CAKE.—Variations in Proportions of Ingredients at Sea Level, at 5,000 Feet and at 11,180 Feet.

Flour........150 grams					Spices, Mixture I........2½ teaspoons			
Egg........48 grams					Salt........½ teaspoon			

Experiment	Baking powder grams	Soda teaspoon	Sugar grams	Fat grams	Liquid* cups	Baking temperature °F.	Checks	Results
Sea Level.	Atmospheric Pressure, 29.9 Inches of Mercury.							
1	7.5 S. A. S.	....	150.0	56	152.5 sweet milk	375–400	3	Very fine grained, light, tender.
2	4.0 Tar.	½	150.0	56	¾	400	2	Some holes, higher than 3.
3	....	⅝	150.0	56	¾	400	2	No holes, quite light.
4	....	¾	150.0	56	¾	400	3	Good, very tender, light.
5	....	¾	150.0	56	¾	375	3	Slightly more even grained than 4.
6	....	½	150.0	56	¾	400	2	Good but slightly more compact than 5.
5,000 Feet.	Atmospheric Pressure, 24.9 Inches of Mercury.							
1	....	½	131.3	49	⅔	375–400	2	Light, fine grained, fluffy, good.
2	....	⅝	131.3	49	¾	375–400	3	Very good texture.
3	....	½	131.3	49	¾	350–375	8	Exceptionally good.
11,180 Feet.	Atmospheric Pressure, 19.9 Inches of Mercury.							
1	....	⅜	112.5	42	¾	350–375	2	Very acceptable.

*Unless otherwise specified, sour milk was used. Sweet milk, when used, is expressed in grams.

Table 63.—Three-Egg Spice Cake.—Variations in Proportions of Ingredients at Sea Level, at 5,000 Feet and at 11,180 Feet.

Flour .... 150 grams	Spices, Mixture I .... 2 1/2 teaspoons
Egg .... 72 grams	Salt .... 1/2 teaspoon

Experiment	Baking powder grams	Soda teaspoon	Sugar grams	Fat grams	Liquid* cups	Baking temperature °F.	Checks	Results
Sea Level.	Atmospheric Pressure, 29.9 Inches of Mercury.							
1	10.0 Tar.	....	175.0	84	122 sweet milk	400	2	Not so good as with sour milk.
2	4.5 Tar.	5/16	162.5	77	5/8	300–350	3	Very good, fine grained, light.
3	5.0 Tar.	5/16	162.5	77	5/8	300–350	4	Slightly lighter than 2.
4	3.8 S. A. S.	5/16	162.5	77	5/8	300–350	5	Similar to 3.
5	....	5/8	175.0	84	5/8	400	2	Better than 6.
6	....	3/8	175.0	84	5/8	400	3	Fine grained, good flavor.
7	....	5/8	162.5	77	5/8	400	2	Fair, not so good as 8.
8	....	5/8	162.5	77	5/8	350	6	Better texture and more even grained than 7.
9	....	1/2	162.5	77	5/8	375–400	2	Not enough leavening.
10	....	1/4	162.5	77	1/2	400	3	Not so light, soft and good as 8.
5,000 Feet.	Atmospheric Pressure, 24.9 Inches of Mercury.							
1	....	3/8	131.3	70	5/8	375–400	3	Fine grained, light, tender, fluffy.
2	....	1/2	131.3	70	5/8	375–400	2	Not so fine grained as 1, holes.
3	....	3/8	131.3	70	5/8	350–375	3	More even texture, but otherwise similar to 1.
4	6.0 Tar.	1/4	137.5	70	5/8	300–350	2	Fine grained but not very light.
5	3.0 Tar.	1/4	137.5	70	5/8	300–350	2	Similar to 4.
6	....	3/8	137.5	70	5/8	325–375	9	Exceptionally good.
11,180 Feet.	Atmospheric Pressure, 19.9 Inches of Mercury.							
1	....	3/8	125.0	63	5/8	350	2	Too loose, coarse.
2	....	1/4	125.0	63	5/8	350	4	Fine, even grained, fluffy, no holes.
3	....	1/8	125.0	63	5/8	350	2	Not light enough.
4	....	1/4	118.7	63	5/8	350	2	Similar to 2.

*Unless otherwise specified, sour milk was used. Sweet milk, when used, is expressed in grams.

Table 64.—Four-Egg Spice Cake.—Variations in Proportions of Ingredients at Sea Level, at 5,000 Feet and at 11,180 Feet.

Flour	150 grams	Spices, Mixture I	2½ teaspoons
Egg	96 grams	Salt	½ teaspoon

Experiment	Baking powder grams	Soda teaspoon	Sugar grams	Fat grams	Liquid* cups	Baking temperature °F.	Checks	Results
Sea Level. Atmospheric Pressure, 29.9 Inches of Mercury.								
1	....	½	175.0	98	½	400	3	Fair, few holes.
2	....	½	175.0	98	½	350	4	Very good, light, soft, even grained.
3	....	¼	175.0	98	½	400	4	Good, fine grained, very tender.
4	4.0 Tar.	¼	175.0	98	½	300–350	6	Exceedingly good.
5,000 Feet. Atmospheric Pressure, 24.9 Inches of Mercury.								
1	....	¼	150.0	91	½	325–375	5	Very light, tender, fluffy, fine grained.
11,180 Feet. Atmospheric Pressure, 19.9 Inches of Mercury.								
1	....	⅛	125.0	84	½	350	4	Very fine grained, light, fluffy, soft.
2	....	⅛	131.3	84	½	350	2	Slightly coarser than 1.
3	....	⅛	118.8	84	½	350	2	Almost as good as 1.

*Sour milk.

TABLE 65.—SPICE CAKES (Using Egg-Yolk Only).—Variations in Proportions of Ingredients at Sea Level and at 5,000 Feet.

Flour....................150 grams

Spices, Mixture I....................2½ teaspoons

Salt.................... ½ teaspoon

Experiment	Baking powder grams	Soda teaspoon	Sugar grams	Fat grams	Liquid* cups	Egg-yolk grams	Baking temperature °F.	Checks	Results
Sea Level. Atmospheric Pressure, 29.9 Inches of Mercury.									
1	9.0 Tar.	¼	162.5	66.5	¾	54	350–400	2	Fine grained, tender, soft.
5,000 Feet. Atmospheric Pressure, 24.9 Inches of Mercury.									
1	....	⅝	143.8	24.5	⅞	18	375–400	2	Fine grained, soft, tender.
1	....	¾	131.3	42.0	⅞	36	350–375	2	A few tunnels, otherwise good.
2	....	⅝	131.3	42.0	⅞	36	350–375	2	Slightly finer grained and better than 1.
1	....	½	137.5	59.5	¾	54	350–375	4	Very fine grained, fluffy, light.
2	....	½	131.3	59.5	¾	54	375–400	2	Similar to 1.
3	6.0 Tar.	....	131.3	60.0	152.5 sweet milk	54	375–400	3	Light, tender, good.
1	5.0 Tar.	....	150.0	77.0	137.0 sweet milk	72	325–350	3	Very good.
2	....	⅜	150.0	77.0	⅝	72	325–350	3	Good, fluffy, tender, fine grained.

*Unless otherwise specified, sour milk was used. Sweet milk, when used, is expressed in grams.

TABLE 66.—SOUR-MILK SPICE CAKE.

The Optimum Proportions of Soda for the Range of Altitudes Between Sea Level and 15,500 Feet.

Atmospheric pressure inches	Altitude feet	1-Egg Soda teaspoon	2-Egg Soda teaspoon	3-Egg Soda teaspoon	4-Egg Soda teaspoon
29.9	Sea level	1¾	1½	1¼	1
28.9	1,018	1¾	1½	1¼	1
27.9	1,977	1½	1¼	1	¾
26.9	3,000	1½	1¼	1	¾
25.9	4,004	1¼	1	¾	½
24.9	5,000	1¼	1	¾	½
23.9	6,200	1¼	1	¾	½
22.9	7,360	1	¾	½	¼
21.9	8,500	1	¾	½	¼
20.9	9,820	1	¾	½	¼
19.9	11,180	¾	½	¼	0
18.9	12,500	¾	½	¼	0
17.9	14,000	0	0	0	0
16.9	15,000	0	0	0	0

SUMMARY OF DIRECTIONS FOR CHOCOLATE CAKES

1. SWEET-MILK CHOCOLATE CAKES.—*a. Recipe.*—1. Using bitter cake chocolate. The same quantities of flour, leavening, salt, sugar and egg as for the foundation butter cakes at all altitudes, are used (see Tables 49, 50, 51 and 52). The shortening is decreased one-half tablespoon for each square of chocolate used. Allow 3 or 4 squares of chocolate, according to taste, for each 3 cups of flour.

2. Using cocoa.—The same quantities of ingredients are used as in the foundation butter cakes except the flour, which is decreased by 1 tablespoon for each tablespoon of cocoa used. The cocoa may be sifted with the flour, or mixed with boiling water to a smooth paste and this added to the fat-sugar mixture.

B. Manipulation.—Follow the standard method of mixing outlined on pages 74 to 75. Melt the chocolate and add to the fat-sugar mixture.

C. *Baking Temperature.*—Tables 67, 68, 69 and 70 show baking temperatures 25 degrees F. lower than those given for corresponding foundation butter cakes.

II. SWEET-MILK DEVIL'S-FOOD CAKES.—*A. Recipe.*—The recipe is the same as that used for the sweet-milk chocolate cake except that for each square of chocolate used, one-fourth cup of boiling water and three-eighths teaspoon of soda are added.

B. Manipulation.—Proceed exactly as for a foundation butter cake (see pages 74 to 75). Melt the chocolate, add the boiling water, blend well, stir in the soda until the mass is full of bubbles and add to the cake batter at the last.

C. Baking Temperature.—See above.

III. SOUR-MILK DEVIL'S-FOOD CAKES.—*A. Recipe.*—The same quantities of flour, salt, egg and sugar (all white, or one-half white and one-half brown) are used as in the foundation butter-cake recipes at the altitudes given in Tables 49, 50, 51 and 52. The shortening is decreased by one-half tablespoon for each square of chocolate used. The amounts of liquid to be allowed to each 3 cups of flour are given in the tabulation to follow:

1-Egg cake	$1\frac{3}{4}$ cup sour milk.	Add $\frac{1}{4}$ cup water per square chocolate.
2-Egg cake	$1\frac{1}{2}$ cup sour milk.	Add $\frac{1}{4}$ cup water per square chocolate.
3-Egg cake	$1\frac{1}{4}$ cup sour milk.	Add $\frac{1}{4}$ cup water per square chocolate.
4-Egg cake	1 cup sour milk.	Add $\frac{1}{4}$ cup water per square chocolate.

If 4 squares of chocolate are used to 3 cups of flour, the 1-egg cake would then require $1\frac{3}{4}$ cups of sour milk and 1 cup of water. For amounts of leavening to be used see Table 72.

B. Manipulation.—See sweet-milk devil's-food cakes for directions.

C. Baking Temperature.—See above.

TABLE 67.—One-Egg Chocolate Cake.—Variations in Proportions of Ingredients at Sea Level, at 5,000 Feet and at 11,180 Feet.

Flour	150 grams	Salt	½ teaspoon
Egg	24 grams	Flavoring	½ teaspoon vanilla

Experiment	Baking powder grams	Soda teaspoon	Sugar grams	Fat grams	Liquid* grams	Chocolate grams	Baking temperature °F.	Checks	Results
Sea Level.	Atmospheric Pressure, 29.9 Inches of Mercury.								
1	12.0 Tar.	none	150.0	24.5	171.4 milk	42	350–375	2	Holes, otherwise fairly satisfactory.
2	8.0 S. A. S.	none	150.0	24.5	171.4 milk	42	350–375	2	Fine grained, not so dry, better than 3.
3	8.0 S. A. S.	none	150.0	28.0	160.1 milk	28	350–375	1	Low in chocolate. Holes, dry, texture poor.
4	8.0 S. A. S.	1	150.0	14.0	½ c. water and ½ c. sour milk	42	350–375	2	Holes, otherwise fairly satisfactory.
5	5.0 S. A. S.	1⅜	150.0	21.0	½ c. water and ⅞ c. sour milk	56	325–350	2	Very good, soft, red, quite fine grained, a few holes.
6	11.0 Tar.	none	150.0	21.0	198.0 milk	56	350	2	Similar in grain and softness to 5 but not red.
7	8.3 S. A. S.	none	150.0	24.5	198.3 milk	42	350	2	Not so good in flavor as 5 or 6, too low in chocolate. Otherwise very good.
5,000 Feet.	Atmospheric Pressure, 24.9 Inches of Mercury.								
1	8.0 Tar.	none	143.8	28.0	183.0	28	375	2	Not very rich but light and tender.
2	8.0 Tar.	none	143.8	21.0	183.0	28	375	2	Light, fluffy, tender.
3	8.0 Tar.	none	143.8	17.5	183.0	28	375	2	Some holes, not so good as 2.
4	8.0 Tar.	none	143.8	17.5	193.0	42	350	3	Best of this group.
11,180 Feet.	Atmospheric Pressure, 19.9 Inches of Mercury.								
1	5.0 Tar.	none	125.0	10.5	193.0	42	350	2	Fair.

*Sweet milk is used unless otherwise specified.

TABLE 68.—TWO-EGG CHOCOLATE CAKE.—Variations in Proportions of Ingredients at Sea Level, at 5,000 Feet and at 11,180 Feet.

Flour .... 150 grams	Salt .... ½ teaspoon
Egg .... 48 grams	Flavoring .... ½ teaspoon vanilla

Experiment	Baking powder grams	Soda teaspoon	Sugar grams	Fat grams	Liquid* grams	Chocolate grams	Baking temperature °F.	Checks	Results
Sea Level.	Atmospheric Pressure, 29.9 Inches of Mercury.								
1	12.0 Tar.	none	150.0	34.5	152.5	42	350–375	2	Few holes, more moist than 2.
2	12.0 Tar.	none	150.0	34.5	137.3	42	350–375	2	Few holes, stretched appearance.
3	10.0 Tar.	none	150.0	45.5	162.5	42	350	2	Fine grained, soft, good taste, not dry.
4	7.5 S. A. S.	none	150.0	45.5	162.5	42	350	2	Similar to 3.
5	6.0 S. A. S.	none	150.0	56.0	152.5	4 T. cocoa	325–350	2	Note that cocoa is used and that 4 T. flour is omitted. Fine grained, soft, light, good.
6	4.0 S. A. S.	1¼	150.0	42.0	½ c. water and ¾ c. sour milk	56	325–350	3	Fine grained, satisfactory.
5,000 Feet.	Atmospheric Pressure, 24.9 Inches of Mercury.								
1	7.0 Tar.	none	131.3	49.0	152.5	28	375	1	Very good, but not enough chocolate.
2	7.0 Tar.	none	131.3	42.0	152.5	28	375	2	Fine grained, tender, light, slightly dry.
3	7.0 Tar.	none	131.3	42.0	160.0	28	375	2	Much better, softer and more moist than 2.
4	7.0 Tar.	none	131.3	38.5	152.5 and 1 T. water	42	350	2	Not red, soft, moist, better taste than 3.
5	7.0 Tar.	none	131.3	38.5	163.0	42	350	2	Good, fine grained, soft and light.
6	none	½	131.3	38.5	¾ c. sour milk	42	325–350	2	Fair.
7	none	½	131.3	38.5	¾ c. sour milk and 1 T. water	42	325	3	Soft, light, finer grained than 6.
8	none	1⅛	131.3	38.5	¾ c. sour milk ½ c. water	56	325–350	2	Red, fine grained, good taste.
11,180 Feet.	Atmospheric Pressure, 19.9 Inches of Mercury.								
1	4.0 Tar.	none	112.5	31.5	163.0	42	350	2	Fair.
2	none	⅞	112.5	28.0	½ c. water and ¾ c. sour milk	56	350–375	3	Rather coarse, good taste, no bad holes (a lower temperature would correct texture).

*Sweet milk is used unless otherwise specified.

TABLE 69.—Three-Egg Chocolate Cake.—Variations in Proportions of Ingredients at Sea Level, at 5,000 Feet and at 11,180 Feet.

Flour .... 150 grams
Egg .... 72 grams
Salt .... ½ teaspoon
Flavoring .... ½ teaspoon vanilla

Experiment	Baking powder grams	Soda teaspoon	Sugar grams	Fat grams	Liquid* grams	Chocolate grams	Baking temperature °F.	Checks	Results
Sea Level.	Atmospheric Pressure, 29.9 Inches of Mercury.								
1	10.0 Tar.	none	162.5	66.5	122.0	42	375–400	2	Some tunnels, otherwise fine grained, good texture, fluffy.
2	9.0 Tar.	none	162.5	66.5	137.3	42	370–375	4	Good, fine grained, fluffy, light.
3	none	½	175.0	73.5	⅝ c. sour milk	42	400	2	Very fine grained, tender, not red, good texture.
4	none	¾	162.5	66.5	¾ c. sour milk	42	350–375	3	Quite good, soft texture.
5	3.0 S. A. S.	1⅛	162.5	63.0	½ c. water ⅝ c. sour milk	56	325–350	5	Fine grained, soft, light.
5,000 Feet.	Atmospheric Pressure, 24.9 Inches of Mercury.								
1	6.0 Tar.	none	131.2	63.0	122.0	28	375	2	Fair, but not so soft, light and moist as desired.
2	6.0 Tar.	none	131.3	59.5	122.0	42	350	2	Too close grained, dry.
3	6.0 Tar.	none	137.5	59.5	132.0	42	350	2	Much better, finer, more moist than 2.
4	6.0 Tar.	¾	137.5	56.0	122.0 and ½ c. water	56	325–350	3	Very good, fine grained, soft.
5	6.0 Tar.	¾	150.0	70.0	122.0 and ½ c. water	56	325–350	2	Fair, but not so good as 4.
6	none	½	137.5	59.5	¾ c. sour milk	42	325–350	3	Very satisfactory.
7	none	1⅛	150.0	56.0	½ c. water ⅝ c. sour milk	56	325–350	10	Fine grained, soft, red, good.
8	none	1⅛	75 brown 75 white	56.0	½ c. water ⅝ c. sour milk	56	325–350	7	Exceptionally good, fine grained, soft, red, moist.
9	6.0 Tar.	½	131.3	59.5	122.0 and ½ c. water	56	350	3	Almost red, fine grained, quite soft.
11,180 Feet.	Atmospheric Pressure, 19.9 Inches of Mercury.								
1	none	1	112.5	49.0	½ c. water ⅝ c. sour milk	56	350–375	2	Coarse, stretched appearance, not red.
2	none	1	125.0	49.0	½ c. water ⅝ c. sour milk	56	350–375	2	Very coarse and crumbly.
3	none	1¾	118.8	49.0	½ c. water ⅝ c. sour milk	56	350–375	3	Rather coarse, good taste, not red, no bad holes.
4	none	¾	118.8	49.0	½ c. water ⅝ c. sour milk	56	325–350	3	Good grain, soft, tender.

*Sweet milk is used unless otherwise specified.

TABLE 70.—Four-Egg Chocolate Cake.—Variations in Proportions of Ingredients at Sea Level, at 5,000 Feet and at 11,180 Feet.

Flour .... 150 grams	Salt .... ½ teaspoon
Egg .... 96 grams	Flavoring .... ½ teaspoon vanilla

Experiment	Baking powder grams	Soda teaspoon	Sugar grams	Fat grams	Liquid* grams	Chocolate grams	Baking temperature °F.	Checks	Results
Sea Level.	Atmospheric Pressure, 29.9 Inches of Mercury.								
1	8.0 Tar.	none	175.0	87.5	101.5	42	350–375	3	Very fine grained.
2	8.0 Tar.	1	200.0	98.0	½ c. water ½ c. sour milk	56	325–350	2	Too tender and crumbly.
3	6.0 Tar.	1	200.0	84.0	½ c. water ½ c. sour milk	56	350–375	2	Good red cake, few holes.
4	6.0 Tar.	1	200.0	77.0	½ c. water ⅜ c. sour milk	56	350–375	2	Heavy layer on bottom, otherwise best of group.
5	6.0 Tar.	1	200.0	70.0	½ c. water ½ c. sour milk	56	350–375	2	Some holes but better than 6.
6	6.0 Tar.	1	200.0	56.0	½ c. water ½ c. sour milk	56	350–375	2	Red, many holes, stretched appearance.
7	4.0 Tar.	1	200.0	77.0	½ c. water ½ c. sour milk	56	350–375	2	Good, fine grained, very few holes.
8	3.0 Tar.	1	175.0	84.0	½ c. water ½ c. sour milk	56	325–350	3	As fine grained and slightly lighter than 9.
9	2.0 Tar.	1	175.0	84.0	½ c. water ½ c. sour milk	56	300–350	3	Red, good grain, very few holes.
10	2.0 S. A. S.	1	175.0	84.0	½ c. water ½ c. sour milk	56	300–350	8	Exceptionally good, fine grained, red, very good in taste, soft, fluffy.
11	6.0 Tar.	1	175.0	84.0	½ c. water ⅜ c. sour milk	56	350–375	2	Smaller and heavier, not so good as 10.
12	6.0 Tar.	1	175.0	77.0	½ c. water ⅜ c. sour milk	56	350–375	2	Fewer holes but not so good as 10.
5,000 Feet.	Atmospheric Pressure, 24.9 Inches of Mercury.								
1	5.0 Tar.	none	150.0	80.5	91.5	28	400	2	Fine grained, tender, light.
2	5.0 Tar.	none	150.0	80.5	102.0	42	350	4	Very much better in taste than 1, good texture.

3	5.0 Tar.	1	100 white 80 brown	77.0	122.0 and ½ c. water	56	350	2	Fair, few holes, not very red.
4	5.0 Tar.	1	100 white 80 brown	91.0	½ c. water ½ c. sour milk	56	350	2	Similar to 3, more holes.
5	3.0 Tar.	1	171.25	70.0	¾ c. water ½ c. sour milk	56	375	4	Similar to corresponding cake at sea level.
6	2.0 Tar.	1	150.0	70.0	⅜ c. water ½ c. sour milk	56	375	2	Not very red, few holes, light, fair texture.
7	2.0 Tar.	1	150.0	70.0	½ c. water ½ c. sour milk	56	350	3	Fine grained, light, tender, **good.**
8	2.0 Tar.	1¼	150.0	77.0	½ c. water ½ c. sour milk	56	350	4	Very good, red, fine grained, fluffy.
9	none	1⅛	75 white 75 brown	77.0	½ c. water ½ c. sour milk	56	325	5	Very good, soft, fine grained.
10	1.3 S. A. S.	1	150.0	77.0	½ c. water ½ c. sour milk	56	350	7	Exceptionally good in every way.
11	1.3 S. A. S.	1	75 white 75 brown	77.0	½ c. water ½ c. sour milk	56	350	4	Same as 10.
12	5.0 Tar.	¾	175.0	77.0	91.5 and ½ c. water	56	325–350	3	Very good, soft, fine grained, light.
11,180 Feet. Atmospheric Pressure, 19.9 Inches of Mercury.									
1	1.5 Tar.	⅝	125.0	70.0	122.0 and 6 T. water	56	350–375	2	Not so good as the following cakes.
2	1.5 Tar.	¾	125.0	70.0	½ c. water ½ c. sour milk.	56	350–375	2	Slightly coarser than 1 but acceptable.
3	1.5 Tar.	½	125.0	70.0	122.0 and 6 T. water	56	350–375	2	Very good texture, fine grained, red.
4	none	¾	125.0	77.0	½ c. water ½ c. sour milk	56	250–275	2	Very tender, even grained, good taste.
5	nonc	¾	125.0	70.0	½ c. water ½ c. sour milk	56	350–375	2	Better than 6, very good.
6	none	⅞	125.0	70.0	½ c. water ½ c. sour milk	56	350–375	2	Slightly coarser than 5.
7	2.0 Tar.	none	125.0	59.3	183.0	42	350–375	2	Very acceptable.

*Sweet milk is used unless otherwise specified.

TABLE 71.—CHOCOLATE CAKE (Using Egg-Yolk Only).—Variations in Proportions of Ingredients at Sea Level, at 5,000 Feet and at 11,180 Feet.

Flour....150 grams	Salt....½ teaspoon
Flavoring....½ teaspoon	

Experiment	Baking powder grams	Soda teaspoon	Sugar grams	Fat grams	Liquid* grams	Egg-yolk grams	Chocolate grams	Baking temperature °F.	Checks	Results
Sea Level.	Atmospheric Pressure, 29.9 Inches of Mercury.									
1	11.0 Tar.	none	150.0	21.0	198.3	18	42	350	2	Much better than 2.
2	12.0 Tar.	none	150.0	21.5	171.4	18	42	350–375	2	Holes, too dry, not satisfactory.
1	10.0 Tar.	none	150.0	42.0	175.0	36	42	350	2	Slightly too dry, fair texture.
2	7.5 S. A. S.	none	150.0	42.0	183.0	36	42	350	2	Much better, softer, and not so dry as 1, quite fine grained.
1	8.0 S. A. S.	none	175.0	63.0	156.0	54	42	375–400	2	Fine grained, light, fluffy.
2	10.0 Tar.	none	162.5	66.5	167.0	54	42	350–375	2	Good, fine grained.
3	10.0 Tar.	none	162.5	56.0	156.0	54	42	375–400	2	Fine grained, soft, light, fluffy.
4	9.0 Tar.	none	162.5	56.0	166.0	54	42	350–375	3	More fluffy and softer than 3, fine grained.
1	8.0 Tar.	none	175.0	70.0	137.5	72	56	325–350	2	Fine grained.
2	6.0 Tar.	1	200.0	77.0	½ c. water ½ c. sour milk	72	56	300–350	2	Good flavor, good cake, very few holes, red, light.
3	4.0 Tar.	1	175.0	77.0	½ c. water ⅝ c. sour milk	72	56	300–350	2	Slightly softer and more moist than 2.
5,000 Feet.	Atmospheric Pressure, 24.9 Inches of Mercury.									
1	8.0 Tar.	none	143.8	28.0	183.0	18	28	375	2	Fair.
2	8.0 Tar.	none	143.8	14.0	205.0	18	42	350	2	Very good for so simple a cake.
1	7.0 Tar.	none	131.3	31.5	175.0	36	42	350	2	Some holes, otherwise good.
2	7.0 Tar.	none	131.3	31.5	183.0	36	42	325–350	3	Softer, lighter, finer grained than 1.
3	none	⅝	131.3	31.5	⅜ c. sour milk 1 T. water	36	42	325–350	2	Fine grained, soft, fluffy.
1	6.0 Tar.	none	131.3	64.0	122.0	54	28	375	2	Fine grained, too tender, crumbly.
2	6.0 Tar.	none	131.3	64.0	152.0	54	28	375	2	More moist, not so crumbly as 1, fine grained, light, tender.
3	6.0 Tar.	none	131.3	49.0	156.0	54	28	375	4	Very good, soft, fluffy.
4	6.0 Tar.	none	137.5	49.0	159.0 and 1 T. water	54	42	350	4	Softer, lighter and more even grained than 3.
5	6.0 Tar.	none	150.0	59.5	½ c. water	54	56	300–325	2	Good taste, fine grained, few holes, stretched appearance.

6	3.0 Tar.	1¼	137.5	45.5	½ c. water ¾ c. sour milk	54	56	325	3	Very good, fine grained, soft.
1	5.0 Tar.	none	150.0	70.0	137.3	72	28	400	2	Light, fine grained, fluffy.
2	5.0 Tar.	none	150.0	66.5	137.3	72	42	350	2	Much better than 1.
3	2.0 Tar.	1¼	150.0	66.5	½ c. water ⅝ c. sour milk	72	56	350	3	Good, light, fine grained, fluffy, red, good texture.
4	2.5 Tar.	1¼	175.0	66.5	½ c. water ⅝ c. sour milk	72	56	325	3	Fair.
11,180 Feet. Atmospheric Pressure, 19.9 Inches of Mercury.										
1	5.0 Tar.	none	125.0	7.0	193.0	18	42	350	2	Fair.
1	4.0 Tar.	none	112.5	24.5	183.0	36	42	350	2	Acceptable.

*Sweet milk is used unless otherwise specified.

TABLE 72.—CHOCOLATE CAKES.—The Optimum Proportions of Leavening Agents for the Range of Altitudes between Sea Level and 15,500 Feet.

Atmospheric pressure inches	Altitude feet	1-Egg			2-Egg			3-Egg			4-Egg		
		Baking powder and teaspoon		Soda teaspoon	Baking powder and teaspoon		Soda teaspoon	Baking powder and teaspoon		Soda teaspoon	Baking powder and teaspoon		Soda teaspoon
		Tar. or S. A. S.			Tar. or S. A. S.			Tar. or S. A. S.			Tar. or S. A. S.		
29.9	Sea Level	3½	2½	2¾	2¾	2	2½	2	1½	2¼	1¼	1	2
28.9	1,018	2¾	2	2¾	2	1½	2½	1¼	1	2¼	½	½	2
27.9	1,977	2	1½	2¾	1¼	1	2½	½	½	2¼	....	....	2
26.9	3,000	1¼	1	2¾	½	½	2½	....	....	2¼	....	....	2
25.9	4,004	½	½	2¾	....	....	2½	....	...	2¼	....	....	2
24.9	5,000	....	....	2¾	....	....	2½	....	....	2¼	....	....	2
23.9	6,200	....	....	2¾	....	....	2½	....	....	2¼	....	....	2
22.9	7,360	....	....	2¾	....	....	2½	....	....	2¼	....	....	2
21.9	8,500	....	....	2½	....	....	2¼	....	....	2	....	....	1¾
20.9	9,820	....	....	2½	....	....	2¼	....	...	2	....	....	1¾
19.9	11,180	....	....	2½	....	....	2¼	....	....	2	....	....	1¾
18.9	12,500	....	....	2¼	....	....	2	....	....	1¾	....	....	1½
17.9	14,000	....	....	2¼	....	....	2	....	....	1¾	....	....	1½
16.9	15,500	....	....	2¼	....	....	2	....	....	1¾	....	....	1½

As was explained earlier, tartrate and phosphate baking powders are required in identical amounts, and the above table is meant to indicate that the quantity of baking powder according to choice is added to the flour and the quantity of soda to the boiling water. For instance the 1-egg cake at sea level requires 3½ t. of tartrate or phosphate baking powder, or 2½ t. of S. A. S. to be added to the flour, and 2¾ t. of soda to be added to the sour milk.

FLOUR MIXTURES LEAVENED BY THE EXPANSION OF AIR—SPONGE CAKES

Included in this sponge-cake group of flour mixtures are those products which employ air as the leavening agent, either alone or with a small amount of carbon dioxide. These products contain no shortening, an almost equal proportion of sugar and flour and a relatively large number of eggs. In the true sponge cake no liquid other than that present in the egg and flavoring is employed.

A sponge cake of excellent quality has a volume about double that of the original batter. The crust is a delicate brown and is slightly sugary. The crumb is very light and resilient, giving a distinctive "spongy" feel and is so tender that it may be pulled apart with practically no effort. The flavor is delicate and the cake seems to melt in the mouth.

This group of cakes may be subdivided into the white sponge, or angel cake, and the yellow sponge cakes. Of this latter group there are two distinct types, the one including sponge and sunshine cakes, to which no baking powder and no liquid have been added, and the other, a false sponge cake, employing egg-yolk, baking powder and liquid. Both the cold-water and hot-water sponge cakes are of this second type.

The tabulation to follow gives the variations found in cook-book recipes. Where necesssary, readjustments were made in these recipes, so that the cup of egg-white was used as the basis for comparison of the angel cakes, and 6 whole eggs were chosen as the basis for the true yellow sponge.

RANGE IN PROPORTIONS OF INGREDIENTS QUOTED IN SPONGE-CAKE RECIPES.

Kind		Flour cup	Cream of tartar teaspoon	Lemon juice	Salt teaspoon	Sugar cup	Egg-white cup	Whole eggs	Baking temperature °F.
White—	Minimum..	¾	½	....	⅛	1	1	....	cold—275
—	Maximum..	1	1	....	¼	1¼	1	....	350
Yellow True	Minimum	1	....	1. T.	⅛	1	....	6	300–350
	Maximum	1	....	½ lemon	1	1	....	6	325–375
Yellow False		All proportions too numerous and too varied to compare.							

The sponge type of cake differs from the others already studied in that the air incorporated in the beaten egg functions as the leavening agent. Upon the application of heat, this air and a small amount of steam formed from the water in the egg and other ingredients, expand and form tiny bubbles thruout the batter. With thoro mixing the distribution of these bubbles is uniform and if the temperature is such that the proteins coagulate or "set" while these bubbles are very tiny, the product has a fine, even texture. If the "setting" is delayed until the bubbles have become large, the cells are ruptured and the sugar solution, in which the gluten strands are soaked, forms globules which cause large holes in the finished product and a cake of coarse texture.

PROCEDURE AND RESULTS

A brief discussion of utensils, ingredients and methods of weighing adopted for the sponge-cake group as a whole, immediately follows:

Since the manipulation and baking temperatures of this group of cakes vary so much with the different types, these will be discussed in connection with each type of sponge cake.

UTENSILS.—The utensils used thruout this series of tests included scales, weights, 2-gallon milk crock or 3-quart mixing bowl, 1-quart bowl, 3 enamel bowls, flour sifter, brush, waxed paper, measuring spoons, wire whip or egg beater, tube pan, oven thermometer and cake racks.

INGREDIENTS.—A cake flour, finely granulated beet sugar, egg-white or whole eggs, cream of tartar or lemon juice to increase the tenacity of the albumin, salt and flavoring, were the ingredients common to all cakes of this group.

The eggs were fresh and at least 1 day old. The white of newly laid egg does not beat up so well as does that of egg slightly older, and this means that it does not incorporate or hold so much air.

In preparing the egg-white it is well to break each egg separately over a dish to insure egg-white free from any trace of egg-yolk and of acceptable standard. The eggs should be cold.

Cake flour and finely granulated sugar are essential if a fine product is to be produced. The cake flour has less gluten than bread flour, thus giving a softer, more tender cake. The fineness of the sugar determines in large measure the fineness of the grain. Unless sugar is very fine, an excellent plan is to place it on waxed paper and roll it for several minutes with a rolling pin. This is done before weighing.

WEIGHING.—The method of weighing is described on pages 40 to 44. In the sponge group of cakes the order is as follows: Flour, sugar, egg.

STUDIES WITH WHITE SPONGE CAKES (ANGEL FOOD)

MANIPULATION.—The most commonly used methods are given here in the form of directions.

1.—Add salt to the egg-white, beat until foamy, then add the cream of tartar and beat until stiff enough to fly from the spoon. Add sugar a little at a time and fold it very carefully, continuing until all of the sugar is used. Fold in the flour, which has been sifted four or five times, then the flavoring. Place in a tube pan.

2.—Add the cream of tartar and the salt to the egg-white, beat only until it is stiff enough to hold its shape and has not lost its shiny appearance. Carefully fold in half of the sugar. Sift the remaining sugar with the flour and fold this into the egg-white-sugar mixture. Fold in the flavoring last.

3.—Beat the egg-white, to which the salt has been added, until foamy, then add the cream of tartar and beat until the egg-white holds its shape. Beat in the sugar gradually and steadily, add the flavoring, and then carefully fold in the flour.

4.—Beat the egg-white, to which the salt has been added, until foamy, then add the cream of tartar and beat until stiff. Gradually beat in the sugar, the flavoring and one-third of the flour. Fold in the remaining flour.

5.—Beat the egg-white, to which the salt has been added, until foamy, then add the cream of tartar and beat until stiff but not dry. Sift the flour and the sugar together nine times. Beat this mixture gradually into the egg-white. Add the flavoring.

6.—Beat the egg-white, to which the salt and the cream of tartar have been added, until stiff enough so that it does not slip in the bowl. Sift the sugar over the top of the beaten egg-white and with as few strokes of the hand as possible fold in the sugar. Do the same with the flavoring and the flour. It is assumed that when the hands are used to fold in the sugar, flour and flavoring they are thoroly cleansed immediately before touching the food materials.

Since the only leavening agent employed in angel cake is the air which is incorporated during the process of mixing, the lightness of the cake depends upon the quantity of air which is caught and held in the beaten egg-white. We also know that there must be a thoro combining of material if the grain of the cake is to be fine and even. Any method that will give a cake that is light and with fine, even grain is satisfactory.

It was found that each of the above methods produced a satisfactory cake. The following method was adopted for general use because the personal equation seemed to be reduced to a minimum.

The egg-white and salt were placed in a 2-gallon milk crock, which was found most convenient because of its size and shape, and beaten with a wire whip until foamy. One-half of the cream of tartar was added to this and the mixture beaten until the egg-white began to hold its shape. The sugar was then added in a slow stream and the beating continued. The mixture became very stiff and slightly viscous, resembling very thick whipped cream. The flavoring was added and folded in with several strokes. The flour, which had been sifted several times with the other half of the cream of tartar was carefully folded in until a homogeneous mixture resulted. This was placed in a tube pan by spoonsful, care being taken that no air pockets occurred in the batter. After the cake was baked and removed from the oven, the pan was inverted and the cake allowed to hang until cold.

The following baking temperatures are advocated in cookbooks:

1.—Place the cake in a cold oven. Gradually increase the temperature so that it will be 200 degrees F. at the end of 15 minutes, 230 degrees F. at the end of 30 minutes, 260 degrees F. at the end of 45 minutes, 300 degrees F. at the end of 1 hour, and 320 to 350 degrees F. at the end of 1¼ hours.

2.—Place the cake in a cold oven. Set the regulator at 250 degrees F. for ½ hour, then at 350 degrees F. for another ½ hour.

3.—Bake at 325 degrees F. for 50 minutes.

4.—Bake at 300 degrees F. for 1½ hours.

To determine what temperature was best the following experiments were carried on:

STUDIES WITH WHITE SPONGE CAKES

Recipe I		Recipe II	
Flour	100 grams	Flour	100 grams
Cream of tartar	1½ teaspoons	Cream of tartar	1½ teaspoons
Salt	¼ teaspoon	Salt	¼ teaspoon
Sugar	300 grams	Sugar	250 grams
Egg-white	330 grams	Egg-white	330 grams
Flavoring	1½ teaspoons	Flavoring	1½ teaspoons

TABLE 73.—WHITE SPONGE CAKE (Angel Food).

A Study of the Influence of the Baking Temperature at Sea Level and at 5,000 Feet.

Experiment	Recipe	Baking temperature °F.	Checks	Results
Sea Level.	Atmospheric Pressure, 29.9 Inches of Mercury.			
1	I	cold to 350	2	Very fair texture, slightly dry.
2	I	cold to 350	3	Similar to 1 but slightly more moist.
3	I	325	7	Fine grained, light, exceptionally tender, light brown crust, moist, fluffy.
4	I	300	3	Not quite so good, more dry, not so delicate and tender as 3.
5,000 Feet.	Atmospheric Pressure, 24.9 Inches of Mercury.			
5	II	cold to 350	3	Fine grained, tender but slightly dry, not so delicate as 7.
6	II	cold to 350	3	Similar to, but slightly more moist than 5.
7	II	325–350*	9	Same as 3. Exceptionally good.
8	II	300	3	Fine grained, but not so fluffy, tender and delicate as 3.

*325 degrees F. for 30 minutes and 350 degrees F. for 20 minutes.

The steady temperature of 325 degrees F. for Recipe I at sea level, and 325 degrees F. for 30 minutes and 350 degrees F. for 20 minutes for Recipe II at an elevation of 5,000 feet gave consistently good results. This temperature gave a delicate brown crust, a fine, even grain and a crumb that was delicately soft and moist. Note that at 5,000 feet altitude Recipe II with the lesser amount of sugar gave better results when baked at 325 to 350 degrees F. than when baked at 300 degrees F.

DETERMINATION OF BEST PROPORTIONS OF INGREDIENTS

TABLE 74.—WHITE SPONGE CAKE (Angel Food).

Variations in Proportions of Ingredients at Sea Level. Atmospheric Pressure, 29.9 Inches of Mercury.

Flour....................100 grams
Salt.................... ¼ teaspoon
Flavoring.................... 1½ teaspoons

Baking temperature........325° F.
Time.................... 50 minutes

Experiment	Cream of tartar teaspoon	Sugar grams	Egg-white grams	Checks	Results
1	1½	300	330	7	Very fine, tender, light, delicate, brown crust. Exceptionally good.
2	1½	250	330	3	Very good, but not so soft, fine grained and tender as 1.
3	1½	200	330	2	Not enough sugar, tougher, not so fine grained as 2.
4	⅔	200	270	2	Not so fine grained and tender as 1.

TABLE 75.—WHITE SPONGE CAKE (Angel Food).

Variations in Proportions of Ingredients at 5,000 Feet. Atmospheric Pressure, 24.9 Inches of Mercury.

Flour....................100 grams
Salt.................... ¼ teaspoon
Flavoring.................... 1½ teaspoons

Baking temperature. 325° F. for 30 minutes, 350°F. for 20 minutes.

Experiment	Cream of tartar teaspoon	Sugar grams	Egg-white grams	Checks	Results
1	1½	300	330	2	Coarse, slightly fallen, shrunken from edges, tough.
2	1½	250	330	10	Very fine and even grained, light, exceptionally tender.
3	1½	200	330	3	Not quite so fine grained, not so soft and delicate as 2, not sweet enough.
4	½	225	266	3	Light and fluffy, but not so fine grained and tender as 2.
5	1	275	355	2	Very light and tender, fluffy texture.
6	1¾	250	420	3	Very light, tender, fluffy, but not so fine grained and soft as 2.

TABLE 76.—WHITE SPONGE CAKE (Angel Food).

Variations in Proportions of Ingredients at 11,180 Feet. Atmospheric Pressure, 19.9 Inches of Mercury.

Egg-white....................330 grams
Salt.................... ¼ teaspoon
Flavoring.................... 1½ teaspoons

Baking temperature (Experiments 1 to 5, 325° F. to 350° F.) (Experiment 5, 350° F. to 375° F., 50 minutes.)

Experiment	Flour grams	Cream of tartar teaspoon	Sugar grams	Checks	Results
1	100.0	1½	250.0	2	Rose high, then fell, shrinking from the pan. Coarse, moist, soggy.
2	100.0	1½	200.0	2	Much better, not so fallen and soggy as 1 but too coarse and moist.
3	125.0	1½	200.0	2	Did not fall so much as 1 but coarse and tough.
4	125.0	1½	187.5	2	Slightly finer than 3, still tough.
5	112.5	1¾	175.0	4	Quite fine grained, tender, light, fluffy.

TABLE 77.—WHITE SPONGE CAKE (Angel Food).

Summary of Results Presented in Tables 74, 75 and 76. The Optimum Proportions of Ingredients at Sea Level, at 5,000 Feet and at 11,180 Feet.

Ingredients	Sea Level (29.9 inches) grams	5,000 Feet (24.9 inches) grams	11,180 Feet (19.9 inches) grams
Flour	100	100	112.5
	(1 c.)	(1 c.)	(1 1/8 c.)
Salt	1/4 t.	1/4 t.	1/4 t.
Cream of tartar	1 1/2 t.	1 1/2 t.	1 3/4 t.
Sugar	300	250	175
	(1 1/2 c.)	(1 1/4 c.)	(7/8 c.)
Egg-white	330	330	330
	(1 3/8 c.)	(1 3/8 c.)	(1 3/8 c.)

STUDIES WITH YELLOW SPONGE CAKES (TRUE SPONGE)

MANIPULATION.—In the case of yellow sponges the added egg-yolks make it necessary to adopt a slightly different method of manipulation than that used in the white sponge cake. Methods directly employed are:

1.—Separate the egg-white from yolk and weigh each separately. Beat the yolk until thick and lemon colored, add the sugar gradually and beat continuously. To this add the lemon juice and rind. Beat the egg-white until stiff, cut and fold into the first mixture alternately with the flour and blend thoroly.

2.—Beat the yolk until thick and lemon colored. Add one-half of the sugar while still beating, then add the lemon juice. Beat the white until stiff, then beat in the remaining sugar. Fold the second mixture into the first. Then carefully fold in the flour thoroly.

3.—Beat the egg-white until it is very stiff and dry. Beat the yolk until thick and lemon colored, beat in the sugar thoroly, then add the lemon juice. Fold this mixture into the egg-white, then fold in the flour.

4.—The procedure is the same as in method 3 up to the point of combining the egg mixtures. The yolk-sugar mixture is folded into the beaten egg-white by hand, likewise the flour. This corresponds to method 6, under white sponge cake (see page 124).

Yellow sponges are similar to white sponges in their characteristics, and the same principles must be observed. Each of these methods gives good results if the maximum amount of air is incorporated and if the ingredients are thoroly blended. Method 2 was adopted for the study of varying the proportions of ingredients.

BAKING TEMPERATURES.—The baking temperatures selected for the studies with this group of sponge cakes are indicated in Tables 78, 79 and 80.

DETERMINATION OF BEST PROPORTIONS OF INGREDIENTS

Data showing the results obtained when varying the proportions of ingredients at the respective altitudes are given on the following page.

TABLE 78.—YELLOW SPONGE CAKE (True Sponge).

Variations in Proportions of Ingredients at Sea Level. Atmospheric Pressure, 29.9 Inches of Mercury.

Salt ¼ teaspoon	Baking temperature 325° F.
Lemon juice 3 tablespoons	Time 1 hour

Experiment	Flour grams	Sugar grams	Egg-white grams	Egg-yolk grams	Checks	Results
1	120	250	180	108	3	Very light, fluffy, fine grained, not quite so tender as 2.
2	100	250	180	108	3	Similar to but more tender and more fluffy than 1.
3	100	250	210	90*	4	Fine grained, tender, exceptionally good.

*This is sometimes designated as sunshine cake.

TABLE 79.—YELLOW SPONGE CAKE (True Sponge).

Variations in Proportions of Ingredients at 5,000 Feet. Atmospheric Pressure, 24.9 Inches of Mercury.

Salt ¼ teaspoon	Baking temperature 325°–350° F.
Lemon juice 3 tablespoons	Time 1 hour

Experiment	Flour grams	Sugar grams	Egg-white grams	Egg-yolk grams	Checks	Results
1	120	250.0	180	108	2	Not so high, light and tender as 3, slightly coarse and moist.
2	120	200.0	180	108	3	Very much better but not so light and tender as 3.
3	100	200.0	180	108	6	Exceptionally good, fine grained, fluffy, very tender.
4	100	187.5	180	108	3	Not so fine, light and tender as 3.
5	100	200.0	210	90*	5	Similar to 3.

*This is sometimes designated as sunshine cake.

TABLE 80.—YELLOW SPONGE CAKE (True Sponge).

Variations in Proportions of Ingredients at 11,180 Feet. Atmospheric Pressure, 19.9 Inches of Mercury.

Salt ¼ teaspoon	Baking temperature 350° F.
Lemon juice 3 tablespoons	Time 1 hour

Experiment	Flour grams	Sugar grams	Egg-white grams	Egg-yolk grams	Checks	Results
1	120.0	250	180	108	2	Coarse, heavy, soggy, fallen.
2	120.0	200	180	108	2	Still slightly fallen, shrunken, coarse and moist.
3	120.0	150	180	108	2	Very much better than 2, quite fine grained, light, but not so tender as 4.
4	112.5	150	180	108	3	The best of this group, quite fine grained, tender, light and fluffy.

TABLE 81.—YELLOW SPONGE CAKE (True Sponge).

Summary of Results Presented in Tables 78, 79 and 80. The Optimum Proportions of Ingredients at Sea Level, at 5,000 Feet and at 11,180 Feet.

Ingredients	Sea Level (29.9 inches) grams	5,000 Feet (24.9 inches) grams	11,180 Feet (19.9 inches) grams
Flour	100	100	112.5
	(1 c.)	(1 c.)	(1⅛ c.)
Salt	¼ t.	¼ t.	¼ t.
Sugar	250	200	150
	(1¼ c.)	(1 c.)	(¾ c.)
Egg-white	180	180	180
	(¾ c. or 6 whites)	(¾ c. or 6 whites)	(¾ c. or 6 whites)
Egg-yolk	108	108	108
	(½ c. or 6 yolks)	(½ c. or 6 yolks)	(½ c. or 6 yolks)
Lemon juice	3 T.	3 T.	3 T.

TABLE 82.—YELLOW SPONGE CAKE (Sunshine).

Summary of Results Presented in Tables 78 and 79. The Optimum Proportions of Ingredients at Sea Level and at 5,000 Feet.

Ingredients	Sea Level (29.9 inches) grams	5,000 Feet (24.9 inches) grams
Flour	100	100
	(1 c.)	(1 c.)
Salt	¼ t.	¼ t.
Sugar	250	200
	(1¼ c.)	(1 c.)
Egg-white	210	210
	(⅞ c. or 7 whites)	(⅞ c. or 7 whites)
Egg-yolk	90	90
	(½ c. — 1 T. or 5 yolks)	(½ c. — 1 T. or 5 yolks)
Lemon juice	3 T.	3 T.

STUDIES WITH FALSE SPONGE CAKES (WATER SPONGE OR FALSE YELLOW SPONGE)

This group includes all sponge cakes which contain water and baking powder in addition to the egg. In most cases the number of eggs is less than in the true sponge cake. There are so many varieties of these false sponge cakes that only one is discussed here—one in which the egg is added in the form of yolk only.

In this egg-yolk sponge cake the yolk is beaten until stiff and lemon colored, the sugar is then added gradually. The lemon juice and boiling water are well blended with the egg-sugar mixture. The flour, salt and baking powder are sifted together several times, then beaten into the first mixture.

The baking temperatures employed in the experiments, cited in Table 83, refer to loaf cakes. The false sponge cake is sometimes baked in layers, in which case the baking temperature is 25 degrees F. higher than for the loaf.

TABLE 83.—FALSE SPONGE CAKE (Water Sponge).—Variations in Proportions of Ingredients at Sea Level, at 5,000 Feet and at 11,180 Feet.

Flour	150 grams	Lemon juice	3 tablespoons
Salt	½ teaspoon	Water	119 grams

Experiment	Sugar grams	Egg-yolk grams	Baking powder tartrate grams	Baking temperature °F.	Checks	Results
Sea Level. Atmospheric Pressure, 29.9 Inches of Mercury.						
1	200	108	7.7	325–350	4	Very spongy, light, fine grained.
2	200	135	7.7	325–350	3	A trifle higher and more fluffy than 1.
3	200	144	7.7	325–350	4	Very loose and fluffy, fine grained.
5,000 Feet. Atmospheric Pressure, 24.9 Inches of Mercury.						
1	200	108	7.7	350–375	2	Slightly coarse and heavy.
2	200	135	7.7	350–375	8	Fluffier and more spongy than 1.
3	200	144	7.7	350–375	6	Very fluffy, spongy.
4	175	108	6.0	350–375	4	Better than 1, but not quite so fluffy and spongy as 2.
11,180 Feet. Atmospheric Pressure, 19.9 Inches of Mercury.						
1	200	108	7.7	375–385	1	Complete failure.
2	200	108	4.0	375–385	1	Same as 1.
3	200	144	4.0	375–385	1	Same as 1.
4	150	108	none	375–385	2	Too fine grained, compact.
5	150	144	none	375–385	1	Better than 4.
6	150	144	2.0	375–385	3	Very satisfactory in every way.
7	150	144	1.5*	375–385	3	Similar to 6.

*S. A. S. baking powder.

TABLE 84.—FALSE SPONGE CAKE (Water Sponge).

Summary of Results Presented in Table 83. The Optimum Proportions of Ingredients at Sea Level, at 5,000 Feet and at 11,180 Feet.

Ingredients	Sea Level (29.9 inches) grams	5,000 Feet* (24.9 inches) grams	11,180 Feet (19.9 inches) grams
Flour	150 (1½ c.)	150 (1½ c.)	150 (1½ c.)
Salt	½ t.	½ t.	½ t.
Baking powder, tartrate	7.7 2 t.	7.7 2 t.	2.0 ½ t.
Sugar	200 (1 c.)	200 (1 c.)	150 (¾ c.)
Water (boiling)	119 (½ c.)	119 (½ c.)	119 (½ c.)
Egg-yolk	108 (½ c. or 6 yolks)	135 (½ c. + 2 T. or 7½ yolks)	144 (½ c. + 2½ T. or 8 yolks)
Lemon juice	3 T.	3 T.	3 T.

*At 5,000 feet, 126 grams of egg-yolk, or 7 yolks, give a satisfactory cake. In this kind of cake the degree of fluffiness desired depends upon one's personal preference.

TABLE 85.—ANGEL FOOD AND YELLOW SPONGE CAKE.—Proportions of Ingredients for the Range of Altitudes Between Sea Level and 15,500 Feet.

Angel Food	
Salt	¼ teaspoon
Egg-white	330 grams (1⅜ cups)
Flavoring	1½ teaspoons

Yellow Sponge	
Salt	¼ teaspoon
Egg-white	180 grams (6)
Egg-yolk	108 grams (6)
Lemon juice	3 tablespoons

		Angel Food			Yellow Sponge	
Atmospheric pressure inches	Altitude feet	Flour grams	Cream of tartar teaspoon	Sugar grams	Flour grams	Sugar grams
29.9	Sea Level	100.0	1½	300	100	250
		1 c.		1½ c.	1 c.	1¼ c.
28.9	1,018	100.0	1½	290	100	240
		1 c.		1½ c.—2½ t.	1 c.	1¼ c. — 2½ t.
27.9	1,977	100.0	1½	280	100	230
		1 c.		1⅜ c. + 1¼ t.	1 c.	1⅛ c. + 1¼ t.
26.9	3,000	100.0	1½	270	100	220
		1 c.		1⅜ c. — 1¼ t.	1 c.	1⅛ c. — 1¼ t.
25.9	4,004	100.0	1½	260	100	210
		1 c.		1¼ c. + 2½ t.	1 c.	1 c. + 2½ t.
24.9	5,000	100.0	1½	250	100	200
		1 c.		1¼ c.	1 c.	1 c.
23.9	6,200	102.1	1½	235	102.1	190
		1 c. + 1 t.		1¼ c. — 1 T.	1 c. + 1 t.	1 c. — 2½ t.
22.9	7,360	104.2	1⅝	220	104.2	180
		1 c. + 2 t.		1⅛ c. — 1¼ t.	1 c. + 2 t.	⅞ c. + 1¼ t.
21.9	8,500	106.3	1⅝	205	106.3	170
		1 c. + 1 T.		1 c. + 1¼ t.	1 c. + 1 T.	⅞ c. — 1¼ t.
20.9	9,820	109.4	1¾	190	109.4	160
		1 c. + 1½ T.		1 c. — 2½ t.	1 c. + 1½ T.	¾ c. + 2½ t.
19.9	11,180	112.5	1¾	175	112.5	150
		1⅛ c.		⅞ c.	1⅛ c.	¾ c.
18.9	12,500	114.6	1¾	160	114.6	140
		1⅛ c. + 1 t.		¾ c. + 2½ t.	1⅛ c. + 1 t.	¾ c. — 2½ t.
17.9	14,000	118.7	1⅞	145	118.7	130
		1⅛ c. + 1 T.		¾ c. — 1¼ t.	1⅛ c. + 1 T.	⅝ c. + 1¼ t.
16.9	15,500	121.9	1⅞	130	121.9	120
		1⅛ c. + 1⅔ T.		¾ c. — 1½ T.	1⅛ c. + 1⅔ T.	⅝ c. — 1¼ t.

FINAL EXPERIMENTS AT ACTUAL ALTITUDES

After the completion of the experimental work in the altitude laboratory, the worker went to four elevations—sea level, 7,000 feet, 9,000 feet and 11,797 feet—and there used the recipes that had given excellent results at the corresponding barometric pressures obtained in the altitude laboratory.

The same utensils and baking temperatures were employed; some of the ingredients were taken from the Fort Collins supply; the eggs, butter and milk were of excellent quality; the manipulation was the same, and the stove and oven were those used in the preliminary experiments discussed earlier in the bulletin.

These checking experiments gave results similar in all respects to those obtained in the altitude laboratory.

DISCUSSION

From the foregoing experiments the following conclusions are drawn:

Each ingredient in a flour mixture bears a very definite relation to every other ingredient, and gives to the product a definite characteristic. Therefore, the quality of the finished product depends upon the quantity of each ingredient which is present in the mixture. Flour furnishes the main structure of the product, while sugar and fat add tenderness and palatability; egg toughens the structure and aids in emulsifying the fat; the leavening agent provides the gas which aerates the dough and produces the light, fluffy product; the liquid is the medium in which the ingredients are dissolved or dispersed.

There is therefore one proportion of ingredients which produces a better product than that produced by other proportions of ingredients.

The method used in combining these ingredients also greatly influences the quality of the finished product. Except in the case of muffins, it was found that the more thoroly the ingredients were mixed, or, as was explained under the manipulation for cakes, the more nearly the batter resembles an emulsion, the finer the quality of the baked product.

The baking of the mixture is of great importance. The temperature of the oven and the time required for baking depend upon the size and richness of the cake batter. Those which have a large proportion of fat and sugar are more likely to be burned and their crusts get harder than the batters which have only a small percentage of these ingredients. The smaller the product to be baked, the higher must be the baking temperature.

The explanation of the effect of a large change in atmospheric pressure, due to change in altitude, is similar in all baking mixtures. In cakes the framework is formed by the protein of the egg and the flour. The strands are soaked in the sugar solution. The leavening agent furnishes the gas incorporated within the batter. As this expands on heating, tiny bubbles are formed thruout the batter. Then the heat coagulates the protein which holds the sugar solution, forming the structure of the finished product. If this "setting" takes place when the air bubbles are very tiny the product has a fine, even texture. But if the air expands into large bubbles and ruptures the cell walls before they have "set," the holes are larger and the cake is coarse-grained. An accompanying feature of the rich flour mixture may be the candy-like texture, discussed under the chemical and physical changes in baking (see page 38).

If, then, the strength of the gluten fibers is increased and the weight of the material to be held, such as sugar and fat, is decreased, this tendency of the cells to rupture is lessened and a finer grained cake results.

SUMMARY

Atmospheric pressure is a very important factor in the baking of flour mixtures. The ingredient upon which this influence is directly exerted is the leavening agent, when this latter is steam or carbon dioxide. These two agents, steam and carbon dioxide, are obtained from materials which are added to the batter by weight, but the volume of gas obtained varies inversely with the atmospheric pressure, according to Boyle's law, at con-

TABLE 86.—ATMOSPHERIC PRESSURES, APPROXIMATE ALTITUDES AND BOILING POINTS OF WATER.

Atmospheric pressure inches	Atmospheric pressure centimeters	Altitude approximate feet	Boiling point of water °F.	Boiling point of water °C.	Pressure in pounds per square inch
29.9	76.00	Sea Level	212.0	100.0	14.78
28.9	73.40	1,018	210.3	99.0	14.19
27.9	70.86	1,977	208.5	98.1	13.69
26.9	68.32	3,000	206.7	97.0	13.20
25.9	65.78	4,004	204.9	96.0	12.71
24.9	63.24	5,000	202.9	95.0	12.22
23.9	60.70	6,200	200.9	93.9	11.73
22.9	58.16	7,360	198.8	92.7	11.24
21.9	55.62	8,500	196.7	91.5	10.75
20.9	53.08	9,820	194.5	90.3	10.26
19.9	50.54	11,180	192.2	89.0	9.77
18.9	48.00	12,500	189.8	87.7	9.28
17.9	45.46	14,000	187.3	86.3	8.78
16.9	42.92	15,500	184.6	84.8	8.29

stant temperatures. Equal amounts of baking powder added to batters at sea level and at 5,000 feet produce 20.0 percent more gas by volume at the higher elevation than at the lower one. The same is true of the steam formed from any water present. Thus the amount of these ingredients should be decreased as the elevation becomes greater (or as the atmospheric pressure is lessened).

Two factors which are affected indirectly by the change in atmospheric pressure are the sugar and the fat. In order to produce satisfactory results the quantity of each of these is diminished as the atmospheric pressure decreases.

Those cakes which contain large percentages of sugar and fat are the ones which show most pronouncedly the effect high altitudes have on the baking of flour mixtures.

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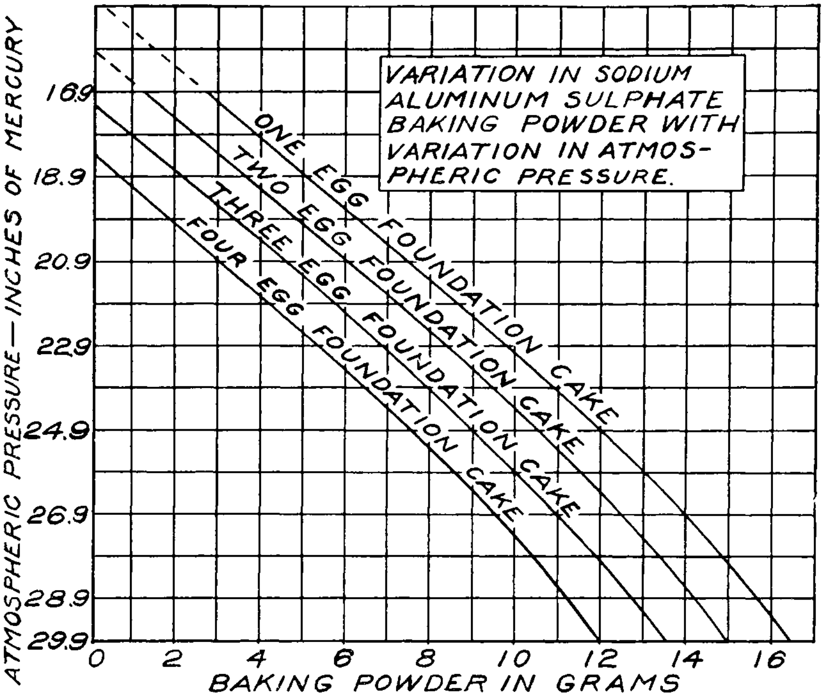
VARIATION IN SODIUM ALUMINUM SULPHATE BAKING POWDER WITH VARIATION IN ATMOSPHERIC PRESSURE.
ONE EGG FOUNDATION CAKE
TWO EGG FOUNDATION CAKE
THREE EGG FOUNDATION CAKE
FOUR EGG FOUNDATION CAKE
ATMOSPHERIC PRESSURE—INCHES OF MERCURY
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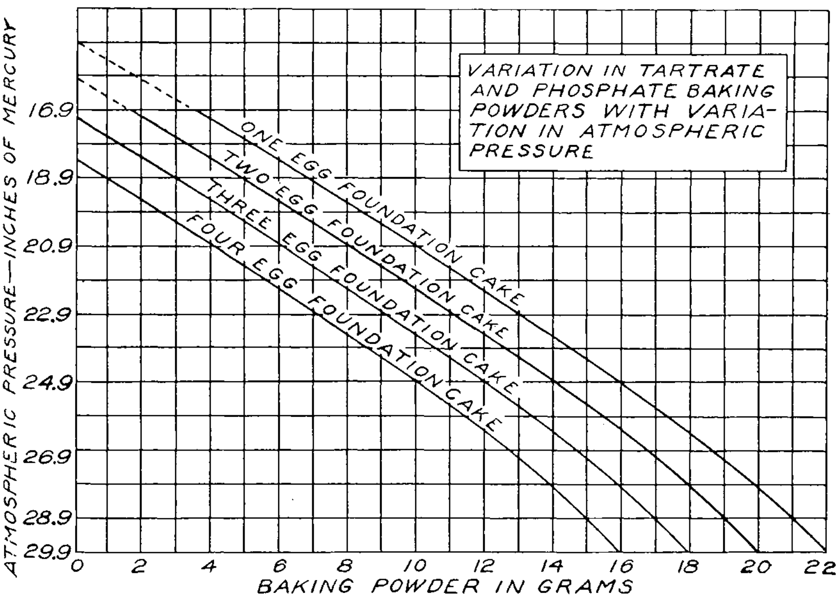
BAKING POWDER IN GRAMS


VARIATION IN TARTRATE AND PHOSPHATE BAKING POWDERS WITH VARIATION IN ATMOSPHERIC PRESSURE
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ATMOSPHERIC PRESSURE—INCHES OF MERCURY
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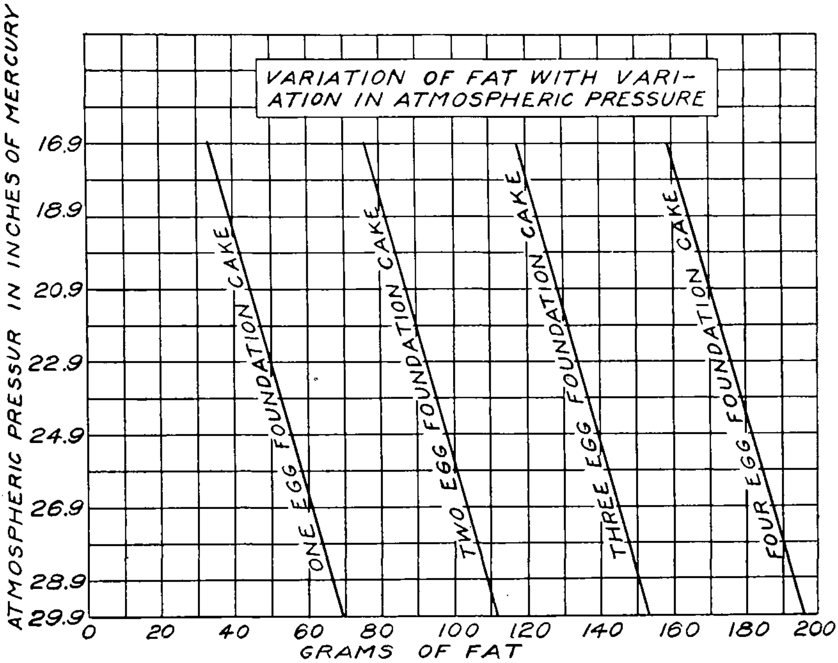
BAKING POWDER IN GRAMS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GRAMS OF FAT
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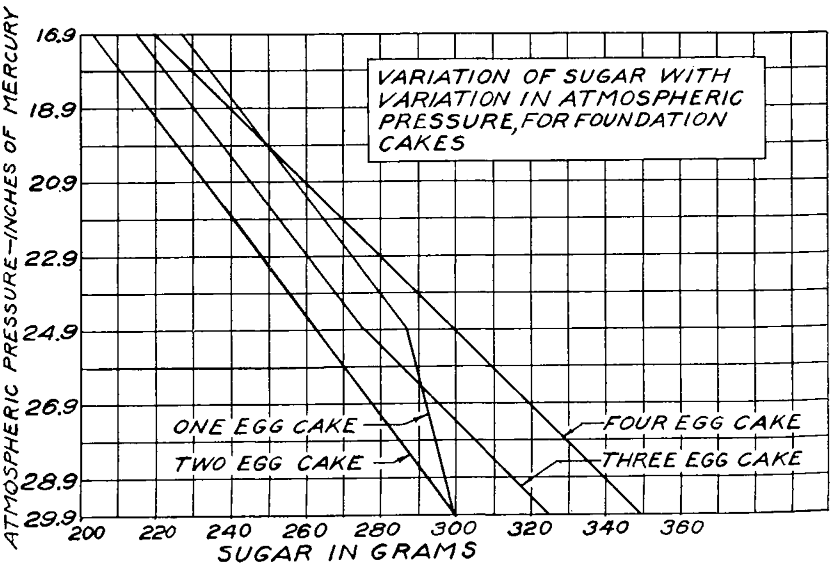
THREE EGG FOUNDATION CAKE
FOUR EGG FOUNDATION CAKE


VARIATION OF SUGAR WITH VARIATION IN ATMOSPHERIC PRESSURE, FOR FOUNDATION CAKES
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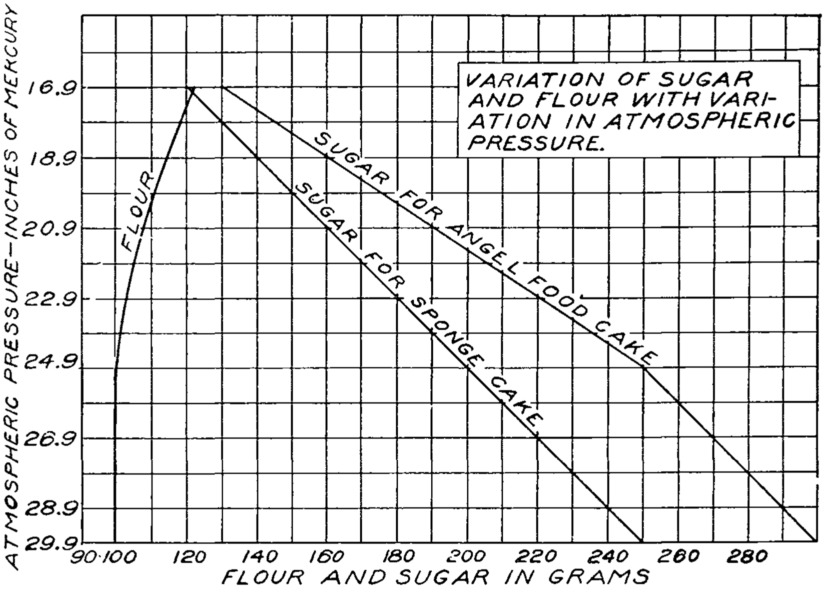
TWO EGG CAKE
FOUR EGG CAKE
THREE EGG CAKE


VARIATION OF SUGAR AND FLOUR WITH VARIATION IN ATMOSPHERIC PRESSURE.
ATMOSPHERIC PRESSURE—INCHES OF MERCURY
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FLOUR AND SUGAR IN GRAMS
FLOUR
SUGAR FOR ANGEL FOOD CAKE
SUGAR FOR SPONGE CAKE

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SUPPLEMENT

In this supplement are summarized for immediate use by the housewife, the recipes that have been evolved from the experimental work presented in Part I. Directions for preparing each type of flour mixture are here outlined, then follow the recipes for sea level and those adjusted for these elevations: 3,000; 4,000; 5,000; 6,200; 7,360; 8,500; and 11,180 feet above sea level.

CONSIDERATION OF SOME FACTORS FOR SUCCESS IN BAKING

UTENSILS.—Having the right equipment with which to do one's baking is an essential feature in achieving success. Bowls of the right size to hold the material most conveniently, of a shape which permits thoro mixing, and heavy enough so that the amount of effort to hold them in place is a minimum, should be used. Egg beaters well made and of the double type, save time and labor. A set of graduated measuring spoons and two measuring cups, preferably of glass—one for dry and one for liquid ingredients—are essential for rapid and accurate work. Wooden spoons are recommended for creaming the shortening. Spatulas are almost indispensible for removing batter from bowls. Enough small bowls should be available so that all the material may be measured before the mixing begins. Baking pans of the right capacity should be used. Racks for cooling are recommended because circulation of air on all sides of the product prevents sweating.

MEASURING.—*Flour.*—Sift a small amount once, then sift from that into the cup. Level the cup with the edge of the spatula.

*Baking Powder.**—Heap the spoon by lifting it up lightly thru the powder; level it with the edge of the spatula.

Granulated Sugar.—Sift into the cup.

Confectioners or Powdered Sugar.—Roll, sift once, then sift into the cup.

Brown Sugar.—Roll, pack into the cup.

Liquids.—Fill the cup or spoon full, empty *completely.*

Fats.—Measure small amounts in a tablespoon. For larger amounts, have the fat at room temperature and pack very solidly into the cup, avoiding air spaces; level with the edge of the spatula.

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*For a discussion of the various types of baking powders, see pages 32 to 33.

Eggs.—Beat enough to break up the egg-white, allow the foam to subside and then measure as liquids (see page 139).

RECIPE OR PROPORTIONS OF INGREDIENTS.—Choose a recipe given for an altitude approximating that at which you reside.

INGREDIENTS.—Only the best quality of ingredients should be used. In each recipe is indicated the type of flour for which the measurement is given.

MANIPULATION.—Accuracy in measurement and the explicit following of the directions outlined are essential.

BAKING.—The baking of any flour mixture is one of the most important factors upon which success depends. Some kind of oven thermometer or regulator is essential in duplicating the results given in this report. Accuracy in reading the thermometer and in regulating the oven is also important.

VARIABLES.—In duplicating a recipe a source of error lies in the lack of uniformity in the spoons and cups selected for measuring. The foregoing suggestions are given to help overcome this difficulty. As a further aid there follows a tabulation of the consequences of various errors in measuring and manipulation.

The personal equation accounts for the fact that the same methods give different results with different individuals. If one is not satisfied with the results obtained from the use of a highly acceptable recipe, perhaps better results may be obtained by a change of manipulation.

With careful work and some painstaking experimentation, many difficulties are overcome. A study of the discussion given under each type of flour mixture in Part I of this bulletin will help in the understanding of the important factors in baking.

SOME RESULTS DUE TO ERRORS IN MEASUREMENT

Ingredient	Too Much	Too Little
Baking Powder	Very coarse and loose, sometimes slightly fallen, bitter taste.	Small, compact and heavy.
Flour	Dry, with a peaked or cracked top, breadlike, compact.	May fall. Slightly heavy or soggy.
Sugar	Tough, heavy, thick crust that is often cracked and sugary, coarse texture, sometimes slightly fallen.	Dry and coarse, tough, does not brown readily.
Fat	Crisp, uneven edges, greasy and crumbly.	Coarse texture with tough crust.
Liquid	Tunnels, heavy streaks and soggy.	Coarse, breadlike, dry.
Temperature	Coarse, thick, tough crust, peaked and often cracked.	Undersized, heavy, close crumbly texture, pale sticky crust.

SOME EQUIVALENTS

1 cup (c.) = 236.6 cubic centimeters (cc.)
1 cup (c.) = 16 tablespoons (T.)
1 tablespoon (T.) = 3 teaspoons (t.)
1 pound (lb.) = 453.59 grams (gms.)
1 ounce (oz.) = 28.35 grams (gms.)
1 pound of butter is approximately 2 cups
1 square of chocolate = 1 ounce or 6 tablespoons (grated)
1 ounce of cocoa = one-fourth cup
1 square of chocolate = one-third cup of cocoa plus one-half tablespoon of butter.

POPOVERS

UTENSILS.—Measuring cups, spoons, 1-quart mixing bowl, 3 pint enamel bowls, flour sifter, egg beater, mixing spoon, spatula, brushes, baking cups and oven thermometer.

INGREDIENTS.—Bread flour, salt, egg, milk, butter.

MANIPULATION.—Measure the ingredients carefully. Sift the dry ingredients into the mixing bowl. Beat the egg and add to it the milk. Add the liquid ingredients to the dry and mix thoroly. Then add the melted butter and beat just enough to produce a smooth batter. Pre-heat the cups in the oven for 10 minutes, oil quickly, fill half full of batter and return to the oven at once.

BAKING TEMPERATURE.—Bake at 450 degrees F. for 30 minutes, then reduce the heat to 350 degrees F. and continue to bake for 15 minutes.

BAKING-POWDER BISCUITS

UTENSILS.—Measuring cups, spoons, 2-quart mixing bowl, 1-pint enamel bowl, flour sifter, wooden spoon, rolling pin, brush, biscuit cutter, baking sheet and oven thermometer.

INGREDIENTS.—Either bread flour or pastry flour may be used, salt, one's choice of baking powder, or, soda and sour milk, fat and liquid.

MANIPULATION.—Sift the dry ingredients into the mixing bowl. Cut in the fat with two knives or rub it in lightly with the finger tips until the mixture has the consistency of cornmeal. Pour in the liquid all at once, stirring gently until the flour has been moistened. Then stir vigorously for several seconds. Turn the mass onto a slightly floured board and knead quickly for several seconds. Pat or roll the dough to a thickness of one-half to three-quarters of an inch. Cut and place in the baking pan so that the biscuits do not touch.

BAKING TEMPERATURE.—Bake at 425 degrees F. for about 12 to 15 minutes. The biscuits should be a delicate brown on top.

MUFFINS

UTENSILS.—Measuring cups, spoons, 2-quart mixing bowl, 3 enamel bowls, flour sifter, wooden spoon, egg beater, spatula, muffin pans and oven thermometer.

INGREDIENTS.—Either bread or pastry flour, salt, one's choice of baking powder, fat, liquid, egg.

When using sour milk in place of sweet, use three-fourths the amount of baking powder given for sweet milk and add one-half teaspoon of soda, dissolved in 1 tablespoon of water, to the liquid ingredients. In case the milk is clabbered, increase the amount of milk to 1 and one-sixteenth cup or 1 and one-eighth cup.

MANIPULATION.—Sift all the dry ingredients into the mixing bowl. Combine the beaten egg, liquid and melted fat. Pour the liquid ingredients all at once into the dry and stir vigorously until the dry ingredients are just dampened. Place the batter into the muffin pans by dipping it up with as little stirring as possible.

BAKING TEMPERATURE.—When using tartrate or phosphate baking powders, bake at 425 degrees F. for about 25 minutes until the crusts have become delicately brown. When using S. A. S. baking powder, start the muffins at 300 degrees F. for about 5 minutes, then increase the heat rapidly to 425 degrees F. for the remainder of the 25-minute baking period.

FOUNDATION BUTTER CAKES

UTENSILS.—Three-quart mixing bowl, 1-quart mixing bowl, 4 enamel bowls, wooden spoon, measuring cups, spoons, spatula, flour sifter, brushes, large tablespoon, cake pans, oven thermometer, cake racks, waxed paper.

INGREDIENTS.—Cake flour, baking powder, salt, granulated sugar, shortening, eggs, milk, flavoring. For the variations of foundation butter cakes—sour-milk, see pages 34, 96 and 97, chocolate, spice, white and gold cakes, see pages 95 to 99.

MANIPULATION.—The manipulation is of great importance in making butter cakes. The directions follow: Cream the shortening until it is the consistency of very thick whipped cream. Add the sugar very gradually at first and cream each addition thoroly, continuing until the sugar has all been incorporated. In the case of the 1 and the 2-egg butter foundation cakes, half the sugar may be beaten into the egg. The mixture should be fluffy and should not separate. Beat the eggs until very light, add slowly to the fat-sugar mixture and then beat together thoroly. Sift the dry ingredients into the 1-quart mixing bowl and add alternately to the fat-sugar-egg mixture with the liquid. Begin and end with the flour. After each addition of flour beat vigorously 50 times, with an under-and-over motion, and after each addition of the milk just stir well enough so that it is thoroly mixed. Add the flavoring last and beat the whole 100 times, with the under-and-over motion, for each egg used. Place the batter in the pans and push well into the corners and to the sides so that the resulting cake will be level.

For the handling of the cake after removing from the oven (see page 76).

BAKING TEMPERATURE.—Place the pan in the center of the lower oven grate which should be about 3 or 4 inches above the bottom of the oven. Definite temperatures are given under each recipe for the layer. Bake the loaf cake at a 25 degree F. lower temperature and cup cakes at 25 degrees F. higher than the layer cake.

VARIATIONS OF FOUNDATION BUTTER CAKES

CHOCOLATE CAKES.—*Utensils.*—The same as for the foundation butter cakes (see page 69).

Ingredients.—The same as for the foundation butter cakes with the addition of chocolate and in some variations the substitution of sour milk for sweet with the addition of soda.

Manipulation.—The same as for the foundation butter cakes. In the regular chocolate cake the chocolate may be melted and added to the fat-sugar mixture, or it may be added at the last. In the devil's-food cake the chocolate is melted above hot water. The cake is mixed as a foundation butter cake, then the boiling water is added to the chocolate and when it has been stirred until it is of an even consistency, the soda is added and the mixture stirred a few seconds. This mixture is added to the cake batter at the last.

Baking Temperature.—The baking temperature is 25 degrees F. lower than for the corresponding foundation butter cakes.

SPICE CAKES.—*Utensils.*—The same as for the foundation butter cakes.

Ingredients.—The same as for the foundation butter cakes with the addition of spice, or with the substitution of sour milk for sweet and the addition of soda.

Spice Mixtures.—I. One teaspoon each of allspice, cinnamon, cloves, ginger and nutmeg.

II. Two teaspoons of cinnamon, 1 teaspoon each of allspice, cloves and nutmeg.

Manipulation.—The procedure is the same as for the foundation butter cake except in the treatment of the spice.

Five teaspoons of either spice mixture is measured out for each 3 cups of flour. To this spice mixture is added 10 teaspoons of boiling water and this paste is allowed to stand a few minutes before being added to the fat-sugar-egg mixture. The addition of the boiling water to the spice brings out the flavor.

Baking Temperature.—For sweet-milk spice cake, the baking temperature is the same as for the foundation butter cake.

For sour-milk spice cake, the baking temperature is 25 degrees F. lower than that for the corresponding foundation butter cakes.

WHITE CAKES.—*Utensils.*—The same as for the foundation butter cakes (see page 69).

Ingredients.—The same as for the foundation butter cakes except that only the white of the egg is used.

Manipulation.—The same as for the foundation butter cakes except that the egg-white is beaten until stiff but not dry, and added at the last. It must be folded in until completely incorporated.

Baking Temperature.—The baking temperatures employed correspond to those accepted for the foundation butter cake.

GOLD CAKES.—*Utensils.*—The same as for the foundation butter cakes.

Ingredients.—The same as for the foundation butter cakes except that egg-yolk only is used.

Manipulation.—The same as for the foundation butter cakes. Beat the egg-yolk until light and lemon colored, then add to the fat-sugar mixture.

Baking Temperature.—The same as for the foundation butter cakes.

SPONGE CAKES

UTENSILS.—Measuring cups and spoons, 2-gallon milk crock or mixing bowl, 1-quart mixing bowl, 3 enamel bowls, flour sifter, brush, waxed paper, wire whip or egg beater, tube pan, thermometer, cake racks.

INGREDIENTS.—Cake flour, finely granulated sugar, cream of tartar or lemon juice, eggs, salt, flavoring.

MANIPULATION.—Attention is called especially to the methods which produced the best results in this laboratory (see pages 124 and 127).

BAKING TEMPERATURE.—The baking temperature is given at the bottom of each recipe.

3,000-FEET RECIPES

For directions see pages 139 to 144.

POPOVERS

Flour	1 c.	Milk	1 c. — 2 t.
Salt	¼ t.	Butter	2 t.
Eggs	2		

BAKING-POWDER BISCUITS

Flour—			
Bread	2 c.	Milk	¾ c.
Or pastry	2⅔ c.	Baking powder—	
Salt	½ t.	Tartrate or phosphate	3¾ t.
Fat	4 T. + 1 t.	Or S. A. S.	2¾ t.

MUFFINS

Flour—		Baking powder—	
Bread	2 c.	Tartrate or phosphate	3¾ t.
Or pastry	2⅔ c.	Or S. A. S.	2¾ t.
Salt	½ t.	Egg	1
Fat	2⅔ to 4 T.	Milk	1 c.
Sugar	2 to 3⅔ T.		

1-EGG FOUNDATION BUTTER CAKE

Cake flour	3 c.	Fat	4 T. + 1¼ t.
Salt	1 t.	Milk	1½ c.
Baking powder—		Egg	1
Tartrate or phosphate	4⅞ t.	Flavoring	1 t.
Or S. A. S.	3½ t.	Bake	390° F.
Sugar	1½ c. — 2 t.	Time	20 to 30 min.

2-EGG FOUNDATION BUTTER CAKE

Cake flour	3 c.	Fat	7 T. + 1¼ t.
Salt	1 t.	Milk	1¼ c.
Baking powder—		Eggs	2
Tartrate or phosphate	4⅜ t.	Flavoring	1 t.
Or S. A. S.	3⅛ t.	Bake	385° F.
Sugar	1⅜ c. + ½ t.	Time	20 to 30 min.

3-EGG FOUNDATION BUTTER CAKE

Cake flour	3 c.	Fat	10 T. + 1¼ t.
Salt	1 t.	Eggs	3
Baking powder—		Milk	1 c.
Tartrate or phosphate	3⅞ t.	Flavoring	1 t.
Or S. A. S.	2¾ t.	Bake	380° F.
Sugar	1½ c. — 1¼ t.	Time	25 to 30 min.

4-EGG FOUNDATION BUTTER CAKE

Cake flour	3 c.	Fat	13 T. + 1¼ t.
Salt	1 t.	Eggs	4
Baking powder—		Milk	¾ c.
Tartrate or phosphate	3¼ t.	Flavoring	1 t.
Or S. A. S.	2⅜ t.	Bake	375° F.
Sugar	1⅝ c. — 1¼ t.	Time	25 to 30 min.

1-EGG CHOCOLATE CAKE

Cake flour	3 c.	Fat	3 T. — ¼ t.
Salt	1 t.	Egg	1
Baking powder—		Milk	1½ c. + 1½ T.
Tartrate or phosphate	4⅞ t.	Chocolate	3 sq.
Or S. A. S.	3½ t.	Vanilla	1 t.
Sugar	1½ c. — 2 t.		

2-Egg Chocolate Cake

Cake flour	3 c.
Salt	1 t.
Baking powder—	
Tartrate or phosphate	4⅜ t.
Or S. A. S.	3⅛ t.
Sugar	1⅜ c. + ½ t.
Fat	6 T. — ¼ t.
Eggs	2
Milk	1¼ c. + 1½ T.
Chocolate	3 sq.
Vanilla	1 t.

3-Egg Chocolate Cake

Cake flour	3 c.
Salt	1 t.
Baking powder—	
Tartrate or phosphate	3⅞ t.
Or S. A. S.	2¾ t.
Sugar	1½ c. — 1¼ t.
Fat	9 T. — ¼ t.
Eggs	3
Milk	1 c. + 1½ T.
Chocolate	3 sq.
Vanilla	1 t.

4-Egg Chocolate Cake

Cake flour	3 c.
Salt	1 t.
Baking powder—	
Tartrate or phosphate	3¼ t.
Or S. A. S.	2⅝ t.
Sugar	1⅝ c. — 1¼ t.
Fat	12 T. — ¼ t.
Eggs	4
Milk	¾ c. + 1½ T.
Chocolate	3 sq.
Vanilla	1 t.

1-Egg Sweet-Milk Devil's-Food Cake

Cake flour	3 c.
Salt	1 t.
Baking powder—	
Tartrate or phosphate	4⅞ t.
Or S. A. S.	3½ t.
Sugar	1½ c. — 2 t.
Fat	2 T. + 1¼ t.
Egg	1
Milk	1½ c.
Chocolate	4 sq.
Water (boiling)	1 c.
Soda	1½ t.
Vanilla	1 t.

2-Egg Sweet-Milk Devil's-Food Cake

Cake flour	3 c.
Salt	1 t.
Baking powder—	
Tartrate or phosphate	4⅜ t.
Or S. A. S.	3⅛ t.
Sugar	1⅜ c. + ½ t.
Fat	5 T. + 1¼ t.
Eggs	2
Milk	1¼ c.
Chocolate	4 sq.
Water (boiling)	1 c.
Soda	1½ t.
Vanilla	1 t.

3-Egg Sweet-Milk Devil's-Food Cake

Cake flour	3 c.
Salt	1 t.
Baking powder—	
Tartrate or phosphate	3⅞ t.
Or S. A. S.	2¾ t.
Sugar	1½ c. — 1¼ t.
Fat	8 T. + 1¼ t.
Eggs	3
Milk	1 c.
Chocolate	4 sq.
Water (boiling)	1 c.
Soda	1½ t.
Vanilla	1 t.

4-Egg Sweet-Milk Devil's-Food Cake

Cake flour	3 c.
Salt	1 t.
Baking powder—	
Tartrate or phosphate	3¼ t.
Or S. A. S.	2⅝ t.
Sugar	1⅝ c. — 1¼ t.
Fat	11 T. + 1¼ t.
Eggs	4
Milk	¾ c.
Chocolate	4 sq.
Water (boiling)	1 c.
Soda	1½ t.
Vanilla	1 t.

1-Egg Sour-Milk Devil's-Food Cake

Cake flour	3 c.	Egg	1
Salt	1 t.	Sour milk	1¾ c.
Baking powder—		Chocolate	4 sq.
Tartrate or phosphate	1¼ t.	Water (boiling)	1 c.
Or S. A. S.	1 t.	Soda	2¾ t.
Sugar	1½ c. — 2 t.	Vanilla	1 t.
Fat	2 T. + 1¼ t.		

2-Egg Sour-Milk Devil's-Food Cake

Cake flour	3 c.	Eggs	2
Salt	1 t.	Sour milk	1½ c.
Baking powder—		Chocolate	4 sq.
Tartrate or phosphate	½ t.	Water (boiling)	1 c.
Or S. A. S.	½ t.	Soda	2½ t.
Sugar	1⅜ c. + ½ t.	Vanilla	1 t.
Fat	5 T. + 1¼ t.		

3-Egg Sour-Milk Devil's-Food Cake

Cake flour	3 c.	Eggs	3
Salt	1 t.	Sour milk	1¼ c.
Baking powder		Chocolate	4 sq.
Tartrate or phosphate	⅛ t.	Water (boiling)	1 c.
Or S. A. S.	⅛ t.	Soda	2¼ t.
Sugar	1½ c. — 1¼ t.	Vanilla	1 t.
Fat	8 T. + 1¼ t.		

4-Egg Sour-Milk Devil's-Food Cake

Cake flour	3 c.	Eggs	4
Salt	1 t.	Sour milk	1 c.
Baking powder—		Chocolate	4 sq.
Tartrate or phosphate	none	Water (boiling)	1 c.
Or S. A. S.	none	Soda	2 t.
Sugar	1⅝ c. — 1¼ t.	Vanilla	1 t.
Fat	11 T. + 1¼ t.		

Sweet-Milk Spice Cake

Use the corresponding foundation butter-cake recipe and add 5 teaspoons of either spice mixture.

1-Egg Sour-Milk Spice Cake

Cake flour	3 c.	Fat	4 T. + 1¼ t.
Salt	1 t.	Egg	1
Baking powder*—		Sour milk	1¾ c.
Tartrate or phosphate	2⅜ t.	Spice	5 t.
Or S. A. S.	1¾ t.	Soda	¾ t.
Sugar	1½ c. — 2 t.		

*If desired, the baking powder may be omitted and the amount of soda doubled.

2-Egg Sour-Milk Spice Cake

Cake flour	3 c.	Fat	7 T. + 1¼ t.
Salt	1 t.	Eggs	2
Baking powder*—		Sour milk	1½ c.
Tartrate or phosphate	2⅛ t.	Spice	5 t.
Or S. A. S.	1⅝ t.	Soda	⅝ t.
Sugar	1⅜ c. + ½ t.		

*If desired, the baking powder may be omitted and the amount of soda doubled.

3-Egg Sour-Milk Spice Cake

Cake flour	3 c.	Fat	10 T. + 1¼ t.
Salt	1 t.	Eggs	3
Baking powder*—		Sour milk	1¼ c.
Tartrate or phosphate	1⅞ t.	Spice	5 t.
Or S. A. S.	1⅜ t.	Soda	½ t.
Sugar	1½ c. — 1¼ t.		

*If desired, the baking powder may be omitted and the amount of soda doubled.

4-Egg Sour-Milk Spice Cake

Cake flour	3 c.	Fat	13 T. + 1¼ t.
Salt	1 t.	Eggs	4
Baking powder*—		Sour milk	1 c.
Tartrate or phosphate	1⅝ t.	Spice	5 t.
Or S. A. S.	1¼ t.	Soda	⅜ t.
Sugar	1⅝ c. — 1¼ t.		

*If desired, the baking powder may be omitted and the amount of soda doubled.

2-Egg-White White Cake

Cake flour	3 c.	Sugar	1½ c. — 2 t.
Salt	1 t.	Fat	4 T. + 2¾ t.
Baking powder—		Egg-whites	2
Tartrate or phosphate	4⅞ t. or 4⅝ t.	Milk	1½ c.
Or S. A. S.	3½ t. or 3¼ t.	Flavoring	1 t.

4-Egg-White White Cake

Cake flour	3 c.	Sugar	1⅜ c. + ½ t.
Salt	1 t.	Fat	8 T. + 1¼ t.
Baking powder—		Egg-whites	4
Tartrate or phosphate	4⅜ t. or 3⅞ t.	Milk	1¼ c.
Or S. A. S.	3⅛ t. or 2⅝ t.	Flavoring	1 t.

6-Egg-White White Cake

Cake flour	3 c.	Sugar	1½ c. — 1¼ t.
Salt	1 t.	Fat	11 T. + 2¾ t.
Baking powder—		Egg-whites	6
Tartrate or phosphate	3⅞ t. or 3⅛ t.	Milk	1 c.
Or S. A. S.	2¾ t. or 2 t.	Flavoring	1 t.

8-Egg-White White Cake

Cake flour	3 c.	Sugar	1⅝ c. — 1¼ t.
Salt	1 t.	Fat	15 T. + 1¼ t.
Baking powder—		Egg-whites	8
Tartrate or phosphate	3¼ or 2¼ t.	Milk	¾ c.
Or S. A. S.	2⅜ or 1⅜ t.	Flavoring	1 t.

2-Egg-Yolk Gold Cake

Cake flour	3 c.	Sugar	1½ c. — 2 t.
Salt	1 t.	Fat	3 T. — ¼ t.
Baking powder—		Egg-yolks	2
Tartrate or phosphate	4⅞ t. or 5⅛ t.	Milk	1½ c. + 1⅓ T.
Or S. A. S.	3½ t. or 3¾ t.	Flavoring	1 t.

4-Egg-Yolk Gold Cake

Cake flour	3 c.	Sugar	1⅜ c. + ½ t.
Salt	1 t.	Fat	6 T. + 1¼ t.
Baking powder—		Egg-yolks	4
Tartrate or phosphate	4⅜ t. or 4⅞ t.	Milk	1¼ c. + 2⅔ T.
Or S. A. S.	3⅛ t. or 3⅝ t.	Flavoring	1 t.

6-EGG-YOLK GOLD CAKE

Cake flour	3 c.
Salt	1 t.
Baking powder—	
Tartrate or phosphate	3⅞ t. or 4⅝ t.
Or S. A. S.	2¾ t. or 3½ t.
Sugar	1½ c. — 1¼ t.
Fat	8 T. — ¼ t.
Egg-yolks	6
Milk	1¼ c.
Flavoring	1 t.

8-EGG-YOLK GOLD CAKE

Cake flour	3 c.
Salt	1 t.
Baking powder—	
Tartrate or phosphate	3⅜ t. or 4⅝ t.
Or S. A. S.	2⅜ t. or 3⅜ t.
Sugar	1⅝ c. — 1¼ t.
Fat	11 T. + 1¼ t.
Egg-yolks	8
Milk	1 c. + 1⅓ T.
Flavoring	1 t.

ANGEL-FOOD CAKE

Cake flour	1 c.
Sugar	1⅜ c. — 1¼ t.
Egg-whites	1⅜ c.
Salt	¼ t.
Cream of tartar	1½ t.
Bake	325° F. Time 50 min.

SPONGE CAKE

Cake flour	1 c.
Sugar	1⅛ c. — 1¼ t.
Egg-whites	6
Egg-yolks	6
Salt	¼ t.
Lemon juice	3 T.
Bake	325° F. Time 1 hour.

4,004-FEET RECIPES

For directions see pages 139 to 144.

POPOVERS

Flour	1 c.
Salt	¼ t.
Eggs	2
Milk	1 c. — 1 t.
Butter	2 t.

BAKING-POWDER BISCUITS

Flour—	
Bread	2 c.
Or pastry	2⅔ c.
Salt	½ t.
Milk	¾ c.
Baking powder—	
Tartrate or phosphate	3¾ t.
Or S. A. S.	2¾ t.
Fat	4 T.

MUFFINS

Flour—	
Bread	2 c.
Or pastry	2⅔ c.
Salt	½ t.
Fat	2⅓ to 4 T.
Sugar	2 to 3⅓ T.
Baking powder—	
Tartrate or phosphate	3¾ t.
Or S. A. S.	2¾ t.
Egg	1
Milk	1 c.

1-EGG FOUNDATION BUTTER CAKE

Cake flour	3 c.
Salt	1 t.
Baking powder—	
Tartrate or phosphate	4½ t.
Or S. A. S.	3¼ t.
Sugar	1½ c. — 2½ t.
Fat	4 T. + ½ t.
Egg	1
Milk	1½ c.
Flavoring	1 t.
Bake	390° F. Time 20 to 30 min.

2-Egg Foundation Butter Cake

Cake flour	3 c.	Fat	7 T. + ½ t.
Salt	1 t.	Eggs	2
Baking powder—		Milk	1¼ c.
Tartrate or phosphate	4 t.	Flavoring	1 t.
Or S. A. S.	2⅞ t.	Bake 385° F.	Time 20 to 30 min.
Sugar	1⅜ c. — 1¼ t.		

3-Egg Foundation Butter Cake

Cake flour	3 c.	Fat	10 T. + ½ t.
Salt	1 t.	Eggs	3
Baking powder—		Milk	1 c.
Tartrate or phosphate	3½ t.	Flavoring	1 t.
Or S. A. S.	2½ t.	Bake 380° F.	Time 25 to 30 min.
Sugar	1⅜ c. + 2½ t.		

4-Egg Foundation Butter Cake

Cake flour	3 c.	Fat	13 T. + ½ t.
Salt	1 t.	Eggs	4
Baking powder—		Milk	¾ c.
Tartrate or phosphate	3 t.	Flavoring	1 t.
Or S. A. S.	2⅛ t.	Bake 375° F.	Time 25 to 30 min.
Sugar	1½ c. + 2½ t.		

1-Egg Chocolate Cake

Cake flour	3 c.	Fat	3 T. — 1 t.
Salt	1 t.	Egg	1
Baking powder—		Milk	1½ c. + 1½ T.
Tartrate or phosphate	4½ t.	Chocolate	3 sq.
Or S. A. S.	3¼ t.	Vanilla	1 t.
Sugar	1½ c. — 2½ t.		

2-Egg Chocolate Cake

Cake flour	3 c.	Fat	6 T. — 1 t.
Salt	1 t.	Eggs	2
Baking powder—		Milk	1¼ c. + 1½ T.
Tartrate or phosphate	4 t.	Chocolate	3 sq.
Or S. A. S.	2⅞ t.	Vanilla	1 t.
Sugar	1⅜ c. — 1¼ t.		

3-Egg Chocolate Cake

Cake flour	3 c.	Fat	9 T. — 1 t.
Salt	1 t.	Eggs	3
Baking powder—		Milk	1 c. + 1½ T.
Tartrate or phosphate	3½ t.	Chocolate	3 sq.
Or S. A. S.	2½ t.	Vanilla	1 t.
Sugar	1⅜ c. + 2½ t.		

4-Egg Chocolate Cake

Cake flour	3 c.	Fat	12 T. — 1 t.
Salt	1 t.	Eggs	4
Baking powder—		Milk	¾ c. + 1½ T.
Tartrate or phosphate	3 t.	Chocolate	3 sq.
Or S. A. S.	2⅛ t.	Vanilla	1 t.
Sugar	1½ c. + 2½ t.		

1-EGG SWEET-MILK DEVIL'S-FOOD CAKE

Cake flour	3 c.	Egg	1
Salt	1 t.	Milk	1½ c.
Baking powder—		Chocolate	4 sq.
Tartrate or phosphate	4½ t.	Water (boiling)	1 c.
Or S. A. S.	3¼ t.	Soda	1½ t.
Sugar	1½ c. — 2½ t.	Vanilla	1 t.
Fat	2 T. + ½ t.		

2-EGG SWEET-MILK DEVIL'S-FOOD CAKE

Cake flour	3 c.	Eggs	2
Salt	1 t.	Milk	1¼ c.
Baking powder—		Chocolate	4 sq.
Tartrate or phosphate	4 t.	Water (boiling)	1 c.
Or S. A. S.	2⅞ t.	Soda	1½ t.
Sugar	1⅜ c. — 1¼ t.	Vanilla	1 t.
Fat	5 T. + ½ t.		

3-EGG SWEET-MILK DEVIL'S-FOOD CAKE

Cake flour	3 c.	Eggs	3
Salt	1 t.	Milk	1 c.
Baking powder—		Chocolate	4 sq.
Tartrate or phosphate	3½ t.	Water (boiling)	1 c.
Or S. A. S.	2½ t.	Soda	1½ t.
Sugar	1⅜ c. + 2½ t.	Vanilla	1 t.
Fat	8 T. + ½ t.		

4-EGG SWEET-MILK DEVIL'S-FOOD CAKE

Cake flour	3 c.	Eggs	4
Salt	1 t.	Milk	¾ c.
Baking powder—		Chocolate	4 sq.
Tartrate or phosphate	3 t.	Water (boiling)	1 c.
Or S. A. S.	2⅛ t.	Soda	1½ t.
Sugar	1½ c. + 2½ t.	Vanilla	1 t.
Fat	11 T. + ½ t.		

1-EGG SOUR-MILK DEVIL'S-FOOD CAKE

Cake flour	3 c.	Egg	1
Salt	1 t.	Sour milk	1¾ c.
Baking powder—		Chocolate	4 sq.
Tartrate or phosphate	½ t.	Water (boiling)	1 c.
Or S. A. S.	½ t.	Soda	2¾ t.
Sugar	1½ c. — 2½ t.	Vanilla	1 t.
Fat	2 T. + ½ t.		

2-EGG SOUR-MILK DEVIL'S-FOOD CAKE

Cake flour	3 c.	Eggs	2
Salt	1 t.	Sour milk	1½ c.
Baking powder—		Chocolate	4 sq.
Tartrate or phosphate	none	Water (boiling)	1 c.
Or S. A. S.	none	Soda	2½ t.
Sugar	1⅜ c. — 1¼ t.	Vanilla	1 t.
Fat	5 T. + ½ t.		

3-Egg Sour-Milk Devil's-Food Cake

Cake flour	3 c.	Eggs	3
Salt	1 t.	Sour milk	1¼ c.
Baking powder—		Chocolate	4 sq.
Tartrate or phosphate	none	Water (boiling)	1 c.
Or S. A. S.	none	Soda	2¼ t.
Sugar	1⅜ c. + 2½ t.	Vanilla	1 t.
Fat	8 T. + ½ t.		

4-Egg Sour-Milk Devil's-Food Cake

Cake flour	3 c.	Eggs	4
Salt	1 t.	Sour milk	1 c.
Baking powder—		Chocolate	4 sq.
Tartrate or phosphate	none	Water (boiling)	1 c.
Or S. A. S.	none	Soda	2 t.
Sugar	1½ c. + 2½ t.	Vanilla	1 t.
Fat	11 T. + ½ t.		

Sweet-Milk Spice Cake

Use the corresponding foundation butter-cake recipe and add 5 teaspoons of either spice mixture.

1-Egg Sour-Milk Spice Cake

Cake flour	3 c.	Fat	4 T. + ½ t.
Salt	1 t.	Egg	1
Baking powder*—		Sour milk	1¾ c.
Tartrate or phosphate	2¼ t.	Soda	⅝ t.
Or S. A. S.	1⅝ t.	Spice	5 t.
Sugar	1½ c. — 2½ t.		

*If desired, the baking powder may be omitted and the amount of soda doubled.

2-Egg Sour-Milk Spice Cake

Cake flour	3 c.	Fat	7 T. + ½ t.
Salt	1 t.	Eggs	2
Baking powder*—		Sour milk	1½ c.
Tartrate or phosphate	2 t.	Soda	½ t.
Or S. A. S.	1⅜ t.	Spice	5 t.
Sugar	1⅜ c. — 1¼ t.		

*If desired, the baking powder may be omitted and the amount of soda doubled.

3-Egg Sour-Milk Spice Cake

Cake flour	3 c.	Fat	10 T. + ½ t.
Salt	1 t.	Eggs	3
Baking powder*—		Sour milk	1¼ c.
Tartrate or phosphate	1¾ t.	Soda	⅜ t.
Or S. A. S.	1¼ t.	Spice	5 t.
Sugar	1⅜ c. + 2½ t.		

*If desired, the baking powder may be omitted and the amount of soda doubled.

4-Egg Sour-Milk Spice Cake

Cake flour	3 c.	Fat	13 T. + 1½ t.
Salt	1 t.	Eggs	4
Baking powder*—		Sour milk	1 c.
Tartrate or phosphate	1½ t.	Soda	¼ t.
Or S. A. S.	1⅛ t.	Spice	5 t.
Sugar	1½ c. + 2½ t.		

*If desired, the baking powder may be omitted and the amount of soda doubled.

2-Egg-White White Cake

Cake flour	3 c.	Sugar	1½ c. − 2½ t.
Salt	1 t.	Fat	4 T. + 2 t.
Baking powder—		Egg-whites	2
Tartrate or phosphate	4½ t. or 4¼ t.	Milk	1½ c.
Or S. A. S.	3¼ t. or 3 t.	Flavoring	1 t.

4-Egg-White White Cake

Cake flour	3 c.	Sugar	1⅜ c. − 1¼ t.
Salt	1 t.	Fat	8 T. + ½ t.
Baking powder—		Egg-whites	4
Tartrate or phosphate	4 t. or 3½ t.	Milk	1¼ c.
Or S. A. S.	2⅞ t. or 2⅜ t.	Flavoring	1 t.

6-Egg-White White Cake

Cake flour	3 c.	Sugar	1⅜ c. + 2½ t.
Salt	1 t.	Fat	11 T. + 2 t.
Baking powder—		Egg-whites	6
Tartrate or phosphate	3½ t. or 2¾ t.	Milk	1 c.
Or S. A. S.	2½ t. or 1¾ t.	Flavoring	1 t.

8-Egg-White White Cake

Cake flour	3 c.	Sugar	1½ c. + 2½ t.
Salt	1 t.	Fat	15 T. + ½ t.
Baking powder—		Egg-whites	8
Tartrate or phosphate	3 t. or 2 t.	Milk	¾ c.
Or S. A. S.	2⅛ t. or 1⅛ t.	Flavoring	1 t.

2-Egg-Yolk Gold Cake

Cake flour	3 c.	Sugar	1½ c. − 2½ t.
Salt	1 t.	Fat	3 T. + 2½ t.
Baking powder—		Egg-yolks	2
Tartrate or phosphate	4½ t. or 4¾ t.	Milk	1½ c. + 1⅓ T.
Or S. A. S.	3¼ t. or 3½ t.	Flavoring	1 t.

4-Egg-Yolk Gold Cake

Cake flour	3 c.	Sugar	1⅜ c. − 1¼ t.
Salt	1 t.	Fat	6 T. + ½ t.
Baking powder—		Egg-yolks	4
Tartrate or phosphate	4 t. or 4½ t.	Milk	1¼ c. + 2⅔ T.
Or S. A. S.	2⅞ t. or 3⅜ t.	Flavoring	1 t.

6-Egg-Yolk Gold Cake

Cake flour	3 c.	Sugar	1⅜ c. + 2½ t.
Salt	1 t.	Fat	8 T. + 2 t.
Baking powder—		Egg-yolks	6
Tartrate or phosphate	3½ t. or 4¼ t.	Milk	1¼ c.
Or S. A. S.	2½ t. or 3¼ t.	Flavoring	1 t.

8-Egg-Yolk Gold Cake

Cake flour	3 c.	Sugar	1½ c. + 2½ t.
Salt	1 t.	Fat	11 T. + ½ t.
Baking powder—		Egg-yolks	8
Tartrate or phosphate	3 t. or 4 t.	Milk	1 c. + 1⅓ T.
Or S. A. S.	2⅛ t. or 3⅛ t.	Flavoring	1 t.

ANGEL-FOOD CAKE

Cake flour	1 c.	Salt	¼ t.
Sugar	1¼ c. + 2½ t.	Cream of tartar	1½ t.
Egg-whites	1⅜ c.	Bake	325° F. to 350° F. Time 50 min.

SPONGE CAKE

Cake flour	1 c.	Salt	¼ t.
Sugar	1 c. + 2½ t.	Lemon juice	3 T.
Egg-whites	6	Bake	325° F. to 350° F.
Egg-yolks	6	Time	1 hour

5,000-FEET RECIPES

For directions see pages 139 to 144.

POPOVERS

Flour	1 c.	Milk	1 c.
Salt	¼ t.	Butter	1½ t.
Eggs	2		

BAKING-POWDER BISCUITS

Flour—		Baking powder—	
Bread	2 c.	Tartrate or phosphate	3¾ t.
Or pastry	2⅔ c.	Or S. A. S.	2¾ t.
Salt	½ t.	Milk	¾ c.
Fat	4 T.		

MUFFINS

		Baking powder—	
Flour—		Tartrate or phosphate	3¾ t.
Bread	2 c.	Or S. A. S.	2¾ t.
Or pastry	2⅔ c.	Egg	1
Salt	½ t.	Milk	1 c.
Fat	2 to 4 T.	Sugar	2 to 3 T.

1-EGG FOUNDATION BUTTER CAKE

Cake flour	3 c.	Fat	4 T.
Salt	1 t.	Egg	1
Baking powder—		Milk	1½ c.
Tartrate or phosphate	4⅛ t.	Flavoring	1 t.
Or S. A. S	3 t.	Bake	395° F.
Sugar	1½ c. — 1 T.	Time	20 to 30 min.

2-EGG FOUNDATION BUTTER CAKE

Cake flour	3 c.	Fat	7 T.
Salt	1 t.	Eggs	2
Baking powder—		Milk	1¼ c.
Tratrate or phosphate	3⅝ t.	Flavoring	1 t.
Or S. A. S	2⅝ t.	Bake	390° F.
Sugar	1⅜ c. — 1 T.	Time	20 to 30 min.

3-EGG FOUNDATION BUTTER CAKE

Cake flour	3 c.	Fat	10 T.
Salt	1 t.	Eggs	3
Baking powder—		Milk	1 c.
Tartrate or phosphate	3⅛ t.	Flavoring	1 t.
Or S. A. S	2¼ t.	Bake	385° F.
Sugar	1⅜ c.	Time	25 to 30 min.

4-Egg Foundation Butter Cake

Cake flour	3 c.	Fat	13 T.
Salt	1 t.	Eggs	4
Baking powder—		Milk	¾ c.
Tartrate or phosphate	2⅝ t.	Flavoring	1 t.
Or S. A. S.	1⅞ t.	Bake	380° F.
Sugar	1½ c.	Time	25 to 30 min.

1-Egg Chocolate Cake

Cake flour	3 c.	Fat	2½ T.
Salt	1 t.	Egg	1
Baking powder—		Milk	1½ c. + 1½ T.
Tartrate or phosphate	4⅛ t.	Chocolate	3 sq.
Or S. A. S.	3 t.	Vanilla	1 t.
Sugar	1½ c. — 1 T.		

2-Egg Chocolate Cake

Cake flour	3 c.	Fat	5½ T.
Salt	1 t.	Eggs	2
Baking powder—		Milk	1¼ c. + 1½ T.
Tartrate or phosphate	3⅝ t.	Chocolate	3 sq.
Or S. A. S.	2⅝ t.	Vanilla	1 t.
Sugar	1⅜ c. — 1 T.		

3-Egg Chocolate Cake

Cake flour	3 c.	Fat	8½ T.
Salt	1 t.	Eggs	3
Baking powder—		Milk	1 c. + 1½ T.
Tartrate or phosphate	3⅛ t.	Chocolate	3 sq.
Or S. A. S.	2¼ t.	Vanilla	1 t.
Sugar	1⅜ c.		

4-Egg Chocolate Cake

Cake flour	3 c.	Fat	11½ T.
Salt	1 t.	Eggs	4
Baking powder—		Milk	¾ c. + 1½ T.
Tartrate or phosphate	2⅝ t.	Chocolate	3 sq.
Or S. A. S.	1⅞ t.	Vanilla	1 t.
Sugar	1½ c.		

1-Egg Sweet-Milk Devil's-Food Cake

Cake flour	3 c.	Egg	1
Salt	1 t.	Milk	1½ c.
Baking powder—		Chocolate	4 sq.
Tartrate or phosphate	4⅛ t.	Water (boiling)	1 c.
Or S. A. S.	3 t.	Soda	1½ t.
Sugar	1½ c. — 1 T.	Vanilla	1 t.
Fat	2 T.		

2-Egg Sweet-Milk Devil's-Food Cake

Cake flour	3 c.	Eggs	2
Salt	1 t.	Milk	1¼ c.
Baking powder—		Chocolate	4 sq.
Tartrate or phosphate	3⅝ t.	Water (boiling)	1 c.
Or S. A. S.	2⅝ t.	Soda	1½ t.
Sugar	1⅜ c. — 1 T.	Vanilla	1 t.
Fat	5 T.		

3-Egg Sweet-Milk Devil's-Food Cake

Cake flour	3 c.	Eggs	3
Salt	1 t.	Milk	1 c.
Baking powder—		Chocolate	4 sq.
Tartrate or phosphate	3⅛ t.	Water (boiling)	1 c.
Or S. A. S.	2¼ t.	Soda	1½ t.
Sugar	1⅜ c.	Vanilla	1 t.
Fat	8 T.		

4-Egg Sweet-Milk Devil's-Food Cake

Cake flour	3 c.	Eggs	4
Salt	1 t.	Milk	¾ c.
Baking powder—		Chocolate	4 sq.
Tartrate or phosphate	2⅝ t.	Water (boiling)	1 c.
Or S. A. S.	1⅞ t.	Soda	1½ t.
Sugar	1½ c.	Vanilla	1 t.
Fat	11 T.		

1-Egg Sour-Milk Devil's-Food Cake

Cake flour	3 c.	Sour milk	1¾ c.
Salt	1 t.	Chocolate	4 sq.
Sugar	1½ c. — 1 T.	Water (boiling)	1 c.
Fat	2 T.	Soda	2¾ t.
Egg	1	Vanilla	1 t.

2-Egg Sour-Milk Devil's-Food Cake

Cake flour	3 c.	Sour milk	1½ c.
Salt	1 t.	Chocolate	4 sq.
Sugar	1⅜ c. — 1 T.	Water (boiling)	1 c.
Fat	5 T.	Soda	2½ t.
Eggs	2	Vanilla	1 t.

3-Egg Sour-Milk Devil's-Food Cake

Cake flour	3 c.	Sour milk	1¼ c.
Salt	1 t.	Chocolate	4 sq.
Sugar	1⅜ c.	Water (boiling)	1 c.
Fat	8 T.	Soda	2¼ t.
Eggs	3	Vanilla	1 t.

4-Egg Sour-Milk Devil's-Food Cake

Cake flour	3 c.	Sour milk	1 c.
Salt	1 t.	Chocolate	4 sq.
Sugar	1½ c.	Water (boiling)	1 c.
Fat	11 T.	Soda	2 t.
Eggs	4	Vanilla	1 t.

Sweet-Milk Spice Cake

Use the corresponding foundation butter-cake recipe and add 5 teaspoons of either spice mixture.

1-Egg Sour-Milk Spice Cake

Cake flour	3 c.	Fat	4 T.
Salt	1 t.	Egg	1
Baking powder*—		Sour milk	1¾ c.
Tartrate or phosphate	2⅛ t.	Soda	⅝ t.
Or S. A. S.	1½ t.	Spice	5 t.
Sugar	1½ c. — 1 T.		

*If desired, the baking powder may be omitted and the amount of soda doubled.

2-Egg Sour-Milk Spice Cake

Cake flour	3 c.	Fat	7 T.
Salt	1 t.	Eggs	2
Baking powder*—		Sour milk	1 1/2 c.
Tartrate or phosphate	1 7/8 t.	Soda	1/2 t.
Or S. A. S.	1 3/8 t.	Spice	5 t.
Sugar	1 3/8 c. — 1 T.		

*If desired, the baking powder may be omitted and the amount of soda doubled.

3-Egg Sour-Milk Spice Cake

Cake flour	3 c.	Fat	10 T.
Salt	1 t.	Eggs	3
Baking powder*—		Sour milk	1 1/4 c.
Tartrate or phosphate	1 5/8 t.	Soda	3/8 t.
Or S. A. S.	1 1/8 t.	Spice	5 t.
Sugar	1 3/8 c.		

*If desired, the baking powder may be omitted and the amount of soda doubled.

4-Egg Sour-Milk Spice Cake

Cake flour	3 c.	Fat	13 T.
Salt	1 t.	Eggs	4
Baking powder*—		Sour milk	1 c.
Tartrate or phosphate	1 3/8 t.	Soda	1/4 t.
Or S. A. S.	1 t.	Spice	5 t.
Sugar	1 1/2 c.		

*If desired, the baking powder may be omitted and the amount of soda doubled.

2-Egg-White White Cake

Cake flour	3 c.	Sugar	1 1/2 c. — 1 T.
Salt	1 t.	Fat	4 T. + 1 1/2 t.
Baking powder—		Egg-whites	2
Tartrate or phosphate	4 1/8 t. or 3 7/8 t.	Milk	1 1/2 c.
Or S. A. S.	3 t. or 2 3/4 t.	Flavoring	1 t.

4-Egg-White White Cake

Cake flour	3 c.	Sugar	1 3/8 c. — 1 T.
Salt	1 t.	Fat	8 T.
Baking powder—		Egg-whites	4
Tartrate or phosphate	3 5/8 t. or 3 1/8 t.	Milk	1 1/4 c.
Or S. A. S.	2 5/8 t. or 2 1/8 t.	Flavoring	1 t.

6-Egg-White White Cake

Cake flour	3 c.	Sugar	1 3/8 c.
Salt	1 t.	Fat	11 T. + 1 1/2 t.
Baking powder—		Egg-whites	6
Tartrate or phosphate	3 1/8 t. or 2 3/8 t.	Milk	1 c.
Or S. A. S.	2 1/4 t. or 1 1/2 t.	Flavoring	1 t.

8-Egg-White White Cake

Cake flour	3 c.	Sugar	1 1/2 c.
Salt	1 t.	Fat	15 T.
Baking powder—		Egg-whites	8
Tartrate or phosphate	2 5/8 t. or 1 5/8 t.	Milk	3/4 c.
Or S. A. S.	1 7/8 t. or 7/8 t.	Flavoring	1 t.

2-Egg-Yolk Gold Cake

Cake flour	3 c.	Sugar	1 1/2 c. — 1 T.
Salt	1 t.	Fat	3 1/2 T.
Baking powder—		Egg-yolks	2
Tartrate or phosphate	4 1/8 t. or 4 3/8 t.	Milk	1 1/2 c. + 1 1/3 T.
Or S. A. S.	3 t. or 3 1/4 t.	Flavoring	1 t

4-Egg-Yolk Gold Cake

Cake flour	3 c.	Sugar	1 3/8 c. — 1 T.
Salt	1 t.	Fat	6 T.
Baking powder—		Egg-yolks	4
Tartrate or phosphate	3 5/8 t. or 4 1/8 t.	Milk	1 1/4 c. + 2 2/3 T.
Or S. A. S.	2 5/8 t. or 3 1/8 t.	Flavoring	1 t.

6-Egg-Yolk Gold Cake

Cake flour	3 c.	Sugar	1 3/8 c.
Salt	1 t.	Fat	8 1/2 T.
Baking powder—		Egg-yolks	6
Tartrate or phosphate	3 1/8 t. or 3 7/8 t.	Milk	1 1/4 c.
Or S. A. S.	2 1/4 t. or 3 t.	Flavoring	1 t.

8-Egg-Yolk Gold Cake

Cake flour	3 c.	Sugar	1 1/2 c.
Salt	1 t.	Fat	11 T.
Baking powder—		Egg-yolks	8
Tartrate or phosphate	2 5/8 t. or 3 5/8 t.	Milk	1 c. + 1 1/3 T.
Or S. A. S.	1 7/8 t. or 2 7/8 t.	Flavoring	1 t.

Angel-Food Cake

Cake flour	1 c.	Salt	1/4 t.
Sugar	1 1/4 c.	Cream of tartar	1 1/2 t.
Egg-whites	1 3/8 c.	Bake	325° F. to 350° F.
		Time	50 min.

Sponge Cake

Cake flour	1 c.	Salt	1/4 t.
Sugar	1 c.	Lemon juice	3 T.
Egg-whites	6	Bake	325° F. to 350° F.
Egg-yolks	6	Time	1 hour

6,200-Feet Recipes

For directions see pages 139 to 144.

Popovers

Flour	1 c.	Milk	1 c. + 1 1/2 t.
Salt	1/4 t.	Butter	1 1/2 t.
Eggs	2		

Baking-Powder Biscuits

Flour—		Baking powder—	
Bread	2 c.	Tartrate or phosphate	3 1/2 t.
Or pastry	2 2/3 c.	Or S. A. S.	2 1/2 t.
Salt	1/2 t.	Fat	4 T. — 1/2 t.
Milk	3/4 c.		

MUFFINS

Flour—		Fat	2 to 4 T.
Bread	2 c.	Egg	1
Or pastry	2⅔ c.	Milk	1 c.
Salt	½ t.	Sugar	2 to 3 T.
Baking powder—			
Tartrate or phosphate	3½ t.		
Or S. A. S.	2½ t.		

1-EGG FOUNDATION BUTTER CAKE

Cake flour	3 c.	Fat	4 T. — ½ t.
Salt	1 t.	Egg	1
Baking powder—		Milk	1½ c.
Tartrate or phosphate	3¾ t.	Flavoring	1 t.
Or S. A. S.	2¾ t.	Bake	395° F.
Sugar	1⅜ c. + 1 t.	Time	20 to 30 min.

2-EGG FOUNDATION BUTTER CAKE

Cake flour	3 c.	Fat	7 T. — ½ t.
Salt	1 t.	Eggs	2
Baking powder—		Milk	1¼ c.
Tartrate or phosphate	3¼ t.	Flavoring	1 t.
Or S. A. S.	2⅜ t.	Bake	390° F.
Sugar	1¼ c. + 1¼ t.	Time	20 to 30 min.

3-EGG FOUNDATION BUTTER CAKE

Cake flour	3 c.	Fat	10 T. — ½ t.
Salt	1 t.	Eggs	3
Baking powder—		Milk	1 c.
Tartrate or phosphate	2¾ t.	Flavoring	1 t.
Or S. A. S.	2 t.	Bake	385° F.
Sugar	1⅜ c. — 1¾ t.	Time	25 to 30 min.

4-EGG FOUNDATION BUTTER CAKE

Cake flour	3 c.	Fat	13 T. — ½ t.
Salt	1 t.	Eggs	4
Baking powder—		Milk	¾ c.
Tartrate or phosphate	2¼ t.	Flavoring	1 t.
Or S. A. S.	1⅝ t.	Bake	380° F.
Sugar	1½ c. — 2½ t.	Time	25 to 30 min.

1-EGG CHOCOLATE CAKE

Cake flour	3 c.	Fat	2 T. + 1 t.
Salt	1 t.	Egg	1
Baking powder—		Milk	1½ c. + 1½ T.
Tartrate or phosphate	3¾ t.	Chocolate	3 sq.
Or S. A. S.	2¾ t.	Vanilla	1 t.
Sugar	1⅜ c. + 1 t.		

2-EGG CHOCOLATE CAKE

Cake flour	3 c.	Fat	5 T. + 1 t.
Salt	1 t.	Eggs	2
Baking powder—		Milk	1¼ c. + 1¼ t.
Tartrate or phosphate	3¼ t.	Chocolate	3 sq.
Or S. A. S.	2⅜ t.	Vanilla	1 t.
Sugar	1¼ c. + 1¼ t.		

3-EGG CHOCOLATE CAKE

Cake flour	3 c.	Fat	8 T. + 1 t.
Salt	1 t.	Eggs	3
Baking powder—		Milk	1 c. + 1½ T.
Tartrate or phosphate	2¾ t.	Chocolate	3 sq.
Or S. A. S.	2 t.	Vanilla	1 t.
Sugar	1⅜ c. — 1¾ t.		

4-EGG CHOCOLATE CAKE

Cake flour	3 c.	Fat	11 T. + 1 t.
Salt	1 t.	Eggs	4
Baking powder—		Milk	¾ c. + 1½ T.
Tartrate or phosphate	2¼ t.	Chocolate	3 sq.
Or S. A. S.	1⅝ t.	Vanilla	1 t.
Sugar	1½ c. — 2½ t.		

1-EGG SWEET-MILK DEVIL'S-FOOD CAKE

Cake flour	3 c.	Egg	1
Salt	1 t.	Milk	1½ c.
Baking powder—		Chocolate	4 sq.
Tartrate or phosphate	3¾ t.	Water (boiling)	1 c.
Or S. A. S.	2¾ t.	Soda	1½ t.
Sugar	1⅜ c. + 1 t.	Vanilla	1 t.
Fat	2 T. — ½ t.		

2-EGG SWEET-MILK DEVIL'S-FOOD CAKE

Cake flour	3 c.	Eggs	2
Salt	1 t.	Milk	1¼ c.
Baking powder—		Chocolate	4 sq.
Tartrate or phosphate	3¼ t.	Water (boiling)	1 c.
Or S. A. S.	2⅜ t.	Soda	1½ t.
Sugar	1¼ c. + 1¼ t.	Vanilla	1 t.
Fat	5 T. — ½ t.		

3-EGG SWEET-MILK DEVIL'S-FOOD CAKE

Cake flour	3 c.	Eggs	3
Salt	1 t.	Milk	1 c.
Baking powder—		Chocolate	4 sq.
Tartrate or phosphate	2¾ t.	Water (boiling)	1 c.
Or S. A. S.	2 t.	Soda	1½ t.
Sugar	1⅜ c. — 1¾ t.	Vanilla	1 t.
Fat	8 T. — ½ t.		

4-EGG SWEET-MILK DEVIL'S-FOOD CAKE

Cake flour	3 c.	Eggs	4
Salt	1 t.	Milk	¾ c.
Baking powder—		Chocolate	4 sq.
Tartrate or phosphate	2¼ t.	Water (boiling)	1 c.
Or S. A. S.	1⅝ t.	Soda	1½ t.
Sugar	1½ c. — 2½ t.	Vanilla	1 t.
Fat	11 T. — ½ t.		

1-EGG SOUR-MILK DEVIL'S-FOOD CAKE

Cake flour	3 c.	Sour milk	1¾ c.
Salt	1 t.	Chocolate	4 sq.
Sugar	1⅜ c. + 1 t.	Water (boiling)	1 c.
Fat	2 T. — ½ t.	Soda	2¾ t.
Egg	1	Vanilla	1 t.

2-Egg Sour-Milk Devil's-Food Cake

Cake flour	3 c.	Sour milk	1½ c.
Salt	1 t.	Chocolate	4 sq.
Sugar	1¼ c. + 1¼ t.	Water (boiling)	1 c.
Fat	5 T. — ½ t.	Soda	2½ t.
Eggs	2	Vanilla	1 t.

3-Egg Sour-Milk Devil's-Food Cake

Cake flour	3 c.	Sour milk	1¼ c.
Salt	1 t.	Chocolate	4 sq.
Sugar	1⅜ c. — 1¾ t.	Water (boiling)	1 c.
Fat	8 T. — ½ t.	Soda	2¼ t.
Eggs	3	Vanilla	1 t.

4-Egg Sour-Milk Devil's-Food Cake

Cake flour	3 c.	Sour milk	1 c.
Salt	1 t.	Chocolate	4 sq.
Sugar	1½ c. — 2½ t.	Water (boiling)	1 c.
Fat	11 T. — ½ t.	Soda	2 t.
Eggs	4	Vanilla	1 t.

Sweet-Milk Spice Cake

Use the corresponding foundation butter-cake recipe and add 5 teaspoons of either spice mixture.

1-Egg Sour-Milk Spice Cake

Cake flour	3 c.	Egg	1
Salt	1 t.	Sour milk	1¾ c.
Sugar	1⅜ c. + 1 t.	Soda	1¼ t.
Fat	4 T. — ½ t.	Spice	5 t.

2-Egg Sour-Milk Spice Cake

Cake flour	3 c.	Eggs	2
Salt	1 t.	Sour milk	1½ c.
Sugar	1¼ c. + 1¼ t.	Soda	1 t.
Fat	7 T. — ½ t.	Spice	5 t.

3-Egg Sour-Milk Spice Cake

Cake flour	3 c.	Eggs	3
Salt	1 t.	Sour milk	1¼ c.
Sugar	1⅜ c. — 1¾ t.	Soda	¾ t.
Fat	10 T. — ½ t.	Spice	5 t.

4-Egg Sour-Milk Spice Cake

Cake flour	3 c.	Eggs	4
Salt	1 t.	Sour milk	1 c.
Sugar	1½ c. — 2½ t.	Soda	½ t.
Fat	13 T. — ½ t.	Spice	5 t.

2-Egg-White White Cake

Cake flour	3 c.	Sugar	1⅜ c. + 1 t.
Salt	1 t.	Fat	4 T. — 2 t.
Baking powder—		Egg-whites	2
Tartrate or phosphate	3¾ t. or 3½ t.	Milk	1½ c.
Or S. A. S.	2¾ t. or 2½ t.	Flavoring	1 t.

4-Egg-White White Cake

Cake flour	3 c.	Sugar	1¼ c. + 1¼ t.
Salt	1 t.	Fat	8 T. − ½ t.
Baking powder—		Egg-whites	4
Tartrate or phosphate	3¼ t. or 2¾ t.	Milk	1¼ c.
Or S. A. S.	2⅜ t. or 1⅞ t.	Flavoring	1 t.

6-Egg-White White Cake

Cake flour	3 c.	Sugar	1⅜ c. − 1¾ t.
Salt	1 t.	Fat	11 T. + 1 t.
Baking powder—		Egg-whites	6
Tartrate or phosphate	2¾ t. or 2 t.	Milk	1 c.
Or S. A. S.	2 t. or 1¼ t.	Flavoring	1 t.

8-Egg-White White Cake

Cake flour	3 c.	Sugar	1½ c. − 2½ t.
Salt	1 t.	Fat	15 T. − ½ t.
Baking powder—		Egg-whites	8
Tartrate or phosphate	2¼ t. or 1¼ t.	Milk	¾ c.
Or S. A. S.	1⅝ t. or ⅝ t.	Flavoring	1 t.

2-Egg-Yolk Gold Cake

Cake flour	3 c.	Sugar	1⅜ c. + 1 t.
Salt	1 t.	Egg-yolks	2
Baking powder—		Fat	3 T. + 1 t.
Tartrate or phosphate	3¾ t. or 4 t.	Milk	1½ c. + 1⅓ T.
Or S. A. S.	2¾ t. or 3 t.	Flavoring	1 t.

4-Egg-Yolk Gold Cake

Cake flour	3 c.	Sugar	1¼ c. + 1¼ t.
Salt	1 t.	Egg-yolks	4
Baking powder—		Fat	6 T. − ½ t.
Tartrate or phosphate	3¼ t. or 3¾ t.	Milk	1¼ c. + 2⅔ T.
Or S. A. S.	2⅜ t. or 2⅞ t.	Flavoring	1 t.

6-Egg-Yolk Gold Cake

Cake flour	3 c.	Sugar	1⅜ c. − 1¾ t
Salt	1 t.	Egg-yolks	6
Baking powder—		Fat	8 T. + 1 t.
Tartrate or phosphate	2¾ t. or 3½ t.	Milk	1¼ c.
Or S. A. S.	2 t. or 2⅜ t.	Flavoring	1 t.

8-Egg-Yolk Gold Cake

Cake flour	3 c.	Sugar	1½ c. − 2½ t.
Salt	1 t.	Egg-yolks	8
Baking powder—		Fat	11 T. − ½ t.
Tartrate or phosphate	2¼ t. or 3¼ t.	Milk	1 c. + 1⅓ T.
Or S. A. S.	1⅝ t. or 2⅝ t.	Flavoring	1 t.

Angel-Food Cake

Cake flour	1 c. + 1 t.	Salt	¼ t.
Sugar	1¼ c. − 1 T.	Cream of tartar	½ t.
Egg-whites	1⅜ c.	Bake	325° F. to 350° F.
		Time	50 min.

Sponge Cake

Cake flour	1 c. + 1 t.	Salt	¼ t.
Sugar	1 c. − 2½ t.	Lemon juice	3 T.
Egg-whites	6	Bake	325° F. to 350° F.
Egg-yolks	6	Time	1 hour

7,360-FEET RECIPES

For directions see pages 139 to 144.

POPOVERS

Flour	1 c.	Milk	1 c. + 1 T.
Salt	1/4 t.	Butter	1 t.
Eggs	2		

BAKING-POWDER BISCUITS

Flour—			
Bread	2 c.	Baking powder—	
Or pastry	2 2/3 c.	Tartrate or phosphate	3 1/2 t.
Salt	1/2 t.	Or S. A. S.	2 1/2 t.
Fat	3 T. + 2 t.	Milk	3/4 c.

MUFFINS

Flour—		Baking powder—	
Bread	2 c.	Tartrate or phosphate	3 1/2 t.
Or pastry	2 2/3 c.	Or S. A. S.	2 1/2 t.
Salt	1/2 t.	Fat	2 to 3 2/3 T.
Egg	1	Sugar	2 to 2 2/3 T.
Milk	1 c.		

1-EGG FOUNDATION BUTTER CAKE

Cake flour	3 c.	Fat	4 T. — 1 1/4 t.
Salt	1 t.	Egg	1
Baking powder—		Milk	1 1/2 c.
Tartrate or phosphate	3 3/8 t.	Flavoring	1 t.
Or S. A. S.	2 1/2 t.	Bake	395° F.
Sugar	1 3/8 c. — 1/2 t.	Time	20 to 30 min.

2-EGG FOUNDATION BUTTER CAKE

Cake flour	3 c.	Fat	7 T. — 1 1/4 t.
Salt	1 t.	Eggs	2
Baking powder—		Milk	1 1/4 c.
Tartrate or phosphate	2 7/8 t.	Flavoring	1 t.
Or S. A. S.	2 1/8 t.	Bake	390° F.
Sugar	1 1/4 c. — 1/2 t.	Time	20 to 30 min.

3-EGG FOUNDATION BUTTER CAKE

Cake flour	3 c.	Fat	10 T. — 1 1/4 t.
Salt	1 t.	Eggs	3
Baking powder—		Milk	1 c.
Tartrate or phosphate	2 3/8 t.	Flavoring	1 t.
Or S. A. S.	1 3/4 t.	Bake	385° F.
Sugar	1 1/4 c. + 2 1/2 t.	Time	20 to 30 min.

4-EGG FOUNDATION BUTTER CAKE

Cake flour	3 c.	Fat	13 T. — 1 1/4 t.
Salt	1 t.	Eggs	4
Baking powder—		Milk	3/4 c.
Tartrate or phosphate	1 7/8 t.	Flavoring	1 t.
Or S. A. S.	1 3/8 t.	Bake	380° F.
Sugar	1 3/8 c. + 1 1/4 t.	Time	20 to 30 min.

1-Egg Chocolate Cake

Cake flour	3 c.	Fat	2 T. + ¼ t.
Salt	1 t.	Egg	1
Baking powder—		Milk	1½ c. + 1½ T.
Tartrate or phosphate	3⅜ t.	Chocolate	3 sq.
Or S. A. S.	2½ t.	Vanilla	1 t.
Sugar	1⅜ c. — ½ t.		

2-Egg Chocolate Cake

Cake flour	3 c.	Fat	5 T. + ¼ t.
Salt	1 t.	Eggs	2
Baking powder—		Milk	1¼ c. + 1½ T.
Tartrate or phosphate	2⅞ t.	Chocolate	3 sq.
Or S. A. S.	2⅛ t.	Vanilla	1 t.
Sugar	1¼ c. — ½ t.		

3-Egg Chocolate Cake

Cake flour	3 c.	Fat	8 T. + ¼ t.
Salt	1 t.	Eggs	3
Baking powder—		Milk	1 c. + 1½ T.
Tartrate or phosphate	2⅜ t.	Chocolate	3 sq.
Or S. A. S.	1¾ t.	Vanilla	1 t.
Sugar	1¼ c. + 2½ t.		

4-Egg Chocolate Cake

Cake flour	3 c.	Fat	11 T. + ¼ t.
Salt	1 t.	Eggs	4
Baking powder—		Milk	¾ c. + 1½ T.
Tartrate or phosphate	1⅞ t.	Chocolate	3 sq.
Or S. A. S.	1⅜ t.	Vanilla	1 t.
Sugar	1⅜ c. + 1¼ t.		

1-Egg Sweet-Milk Devil's-Food Cake

Cake flour	3 c.	Egg	1
Salt	1 t.	Milk	1½ c.
Baking powder—		Chocolate	4 sq.
Tartrate or phosphate	3⅜ t.	Water (boiling)	1 c.
Or S. A. S.	2½ t.	Soda	1½ t.
Sugar	1⅜ c. — ½ t.	Vanilla	1 t.
Fat	2 T. — 1¼ t.		

2-Egg Sweet-Milk Devil's-Food Cake

Cake flour	3 c.	Eggs	2
Salt	1 t.	Milk	1¼ c.
Baking powder—		Chocolate	4 sq.
Tartrate or phosphate	2⅞ t.	Water (boiling)	1 c.
Or S. A. S.	2⅛ t.	Soda	1½ t.
Sugar	1¼ c. — ½ t.	Vanilla	1 t.
Fat	5 T. — 1¼ t.		

3-Egg Sweet-Milk Devil's-Food Cake

Cake flour	3 c.	Eggs	3
Salt	1 t.	Milk	1 c.
Baking powder—		Chocolate	4 sq.
Tartrate or phosphate	2⅜ t.	Water (boiling)	1 c.
Or S. A. S.	1¾ t.	Soda	1½ t.
Sugar	1¼ c. + 2½ t.	Vanilla	1 t.
Fat	8 T. — 1¼ t.		

4-Egg Sweet-Milk Devil's-Food Cake

Cake flour	3 c.	Eggs	4
Salt	1 t.	Milk	¾ c.
Baking powder—		Chocolate	4 sq.
Tartrate or phosphate	1⅞ t.	Water (boiling)	1 c.
Or S. A. S.	1⅜ t.	Soda	1½ t.
Sugar	1⅜ c. + 1¼ t.	Vanilla	1 t.
Fat	11 T. — 1¼ t.		

1-Egg Sour-Milk Devil's-Food Cake

Cake flour	3 c.	Sour milk	1¾ c.
Salt	1 t.	Chocolate	4 sq.
Sugar	1⅜ c. — ½ t.	Water (boiling)	1 c.
Fat	2 T. — 1¼ t.	Soda	2¾ t.
Egg	1	Vanilla	1 t.

2-Egg Sour-Milk Devil's-Food Cake

Cake flour	3 c.	Sour milk	1½ c.
Salt	1 t.	Chocolate	4 sq.
Sugar	1¼ c. — ½ t.	Water (boiling)	1 c.
Fat	5 T. — 1¼ t.	Soda	2½ t.
Eggs	2	Vanilla	1 t.

3-Egg Sour-Milk Devil's-Food Cake

Cake flour	3 c.	Sour milk	1¼ c.
Salt	1 t.	Chocolate	4 sq.
Sugar	1¼ c. + 2½ t.	Water (boiling)	1 c.
Fat	8 T. — 1¼ t.	Soda	2¼ t.
Eggs	3	Vanilla	1 t.

4-Egg Sour-Milk Devil's-Food Cake

Cake flour	3 c.	Sour milk	1 c.
Salt	1 t.	Chocolate	4 sq.
Sugar	1⅜ c. + 1¼ t.	Water (boiling)	1 c.
Fat	11 T. — 1¼ t.	Soda	2 t.
Eggs	4	Vanilla	1 t.

Sweet-Milk Spice Cake

Use the corresponding foundation butter-cake recipe and add 5 teaspoons of either spice mixture.

1-Egg Sour-Milk Spice Cake

Cake flour	3 c.	Egg	1
Salt	1 t.	Sour milk	1¾ c.
Sugar	1⅜ c. — ½ t.	Soda	1 t.
Fat	4 T. — 1¼ t.	Spice	5 t.

2-Egg Sour-Milk Spice Cake

Cake flour	3 c.	Eggs	2
Salt	1 t.	Sour milk	1½ c.
Sugar	1¼ c. — ½ t.	Soda	¾ t.
Fat	7 T. — 1¼ t.	Spice	5 t.

3-Egg Sour-Milk Spice Cake

Cake flour	3 c.	Eggs	3
Salt	1 t.	Sour milk	1¼ c.
Sugar	1¼ c. + 2½ t.	Soda	½ t.
Fat	10 T. — 1¼ t.	Spice	5 t.

4-Egg Sour-Milk Spice Cake

Cake flour	3 c.	Eggs	4
Salt	1 t.	Sour milk	1 c.
Sugar	1⅜ c. + 1¼ t.	Soda	¼ t.
Fat	13 T. — 1¼ t.	Spice	5 t.

2-Egg-White White Cake

Cake flour	3 c.	Fat	4 T. + ¼ t.
Salt	1 t.	Egg-whites	2
Baking powder—		Milk	1½ c.
Tartrate or phosphate	3⅜ t. or 3⅛ t.	Flavoring	1 t.
Or S. A. S.	2½ t. or 2¼ t.		
Sugar	1⅜ c. — ½ t.		

4-Egg-White White Cake

Cake flour	3 c.	Sugar	1¼ c. — ½ t.
Salt	1 t.	Fat	8 T. — 1¼ t.
Baking powder—		Egg-whites	4
Tartrate or phosphate	2⅞ t. or 2⅜ t.	Milk	1¼ c.
Or S. A. S.	2⅛ t. or 1⅝ t.	Flavoring	1 t.

6-Egg-White White Cake

Cake flour	3 c.	Sugar	1¼ c. + 2½ t.
Salt	1 t.	Fat	11 T. + ¼ t.
Baking powder—		Egg-whites	6
Tartrate or phosphate	2⅜ t. or 1⅝ t.	Milk	1 c.
Or S. A. S.	1¾ t. or 1 t.	Flavoring	1 t.

8-Egg-White White Cake

Cake flour	3 c.	Sugar	1⅜ c. + 1¼ t.
Salt	1 t.	Fat	15 T. — 1¼ t.
Baking powder—		Egg-whites	8
Tartrate or phosphate	1⅞ t. or ⅞ t.	Milk	¾ c.
Or S. A. S.	1⅜ t. or ⅜ t.	Flavoring	1 t.

2-Egg-Yolk Gold Cake

Cake flour	3 c.	Sugar	1⅜ c. — ½ t.
Salt	1 t.	Fat	3 T. + ¼ t.
Baking powder—		Egg-yolks	2
Tartrate or phosphate	3⅜ t. or 3⅝ t.	Milk	1½ c. + 1⅓ T.
Or S. A. S.	2½ t. or 2¾ t.	Flavoring	1 t.

4-Egg-Yolk Gold Cake

Cake flour	3 c.	Sugar	1¼ c. — ½ t.
Salt	1 t.	Fat	6 T. — 1¼ t.
Baking powder—		Egg-yolks	4
Tartrate or phosphate	2⅞ t. or 3⅜ t.	Milk	1¼ c. + 2⅔ T.
Or S. A. S.	2⅛ t. or 2⅝ t.	Flavoring	1 t.

6-Egg-Yolk Gold Cake

Cake flour	3 c.	Sugar	1¼ c. + 2½ t.
Salt	1 t.	Fat	8 T. + ¼ t.
Baking powder—		Egg-yolks	6
Tartrate or phosphate	2⅜ t. or 3⅛ t.	Milk	1¼ c.
Or S. A. S.	1¾ t. or 2½ t.	Flavoring	1 t.

8-Egg-Yolk Gold Cake

Cake flour	3 c.	Sugar	1⅜ c. + 1¼ t
Salt	1 t.	Fat	11 T. − 1¼ t.
Baking powder—		Egg-yolks	8
Tartrate or phosphate	1⅞ t. or 2⅞ t.	Milk	1 c. + 1⅓ T.
Or S. A. S	1⅜ t. or 2⅜ t.	Flavoring	1 t.

Angel-Food Cake

Cake flour	1 c. + 2 t.	Egg-whites	1⅜ o.
Salt	¼ t.	Cream of tartar	1⅝ t.
Sugar	1⅛ c. — 1¼ t.	Bake	350° F.
		Time	50 min.

Sponge Cake

Cake flour	1 c. + 2 t.	Salt	¼ t.
Sugar	⅞ c. + 1¼ t.	Lemon juice	3 T.
Egg-whites	6	Bake	350° F.
Egg-yolks	6	Time	1 hour

8,500-Feet Recipes

For directions see pages 139 to 144.

Popovers

Flour	1 c.	Milk	1 c. + 1⅓ T.
Salt	¼ t.	Butter	1 t.
Eggs	2		

Baking-Powder Biscuits

Flour—		Baking powder—	
Bread	2 c.	Tartrate or phosphate	3¼ t.
Or pastry	2⅔ c.	Or S. A. S	2½ t.
Salt	½ t.	Fat	3 T. + 1 t
		Milk	¾ c.

Muffins

Flour—			
Bread	2 c.	Fat	2 to 3⅓ T.
Or pastry	2⅔ c.	Egg	1
Salt	½ t.	Milk	1 c.
Baking powder—		Sugar	2 to 2⅔ T.
Tartrate or phosphate	3¼ t.		
Or S. A. S	2½ t.		

1-Egg Foundation Butter Cake

Cake flour	3 c.	Fat	3 T. + 1¼ t.
Salt	1 t.	Egg	1
Baking powder—		Milk	1½ c.
Tartrate or phosphate	3 t.	Flavoring	1 t.
Or S. A. S	2⅛ t.	Bake	395° F.
Sugar	1⅜ c. — 1½ t.	Time	20 to 30 min.

2-Egg Foundation Butter Cake

Cake flour	3 c.	Fat	6 T. + 1¼ t.
Salt	1 t.	Eggs	2
Baking powder—		Milk	1¼ c.
Tartrate or phosphate	2½ t.	Flavoring	1 t.
Or S. A. S	1¾ t.	Bake	390° F.
Sugar	1¼ c. — 2½ t.	Time	20 to 30 min.

3-Egg Foundation Butter Cake

Cake flour	3 c.	Fat	9 T. + 1¼ t.
Salt	1 t.	Eggs	3
Baking powder—		Milk	1 c.
Tartrate or phosphate	2 t.	Flavoring	1 t.
Or S. A. S.	1⅜ t.	Bake	385° F.
Sugar	1¼ c. + ¾ t.	Time	25 to 30 min.

4-Egg Foundation Butter Cake

Cake flour	3 c.	Fat	12 T. + 1¼ t.
Salt	1 t.	Eggs	4
Baking powder—		Milk	¾ c.
Tartrate or phosphate	1½ t.	Flavoring	1 t.
Or S. A. S.	1 t.	Bake	380° F.
Sugar	1⅜ c. — 1¼ t.	Time	25 to 30 min.

1-Egg Chocolate Cake

Cake flour	3 c.	Fat	2 T. — ¼ t.
Salt	1 t.	Egg	1
Baking powder—		Milk	1½ c. + 1½ T.
Tartrate or phosphate	3 t.	Chocolate	3 sq.
Or S. A. S.	2⅛ t.	Vanilla	1 t.
Sugar	1⅜ c. — 1½ t.		

2-Egg Chocolate Cake

Cake flour	3 c.	Fat	5 T. — ¼ t.
Salt	1 t.	Eggs	2
Baking powder—		Milk	1¼ c. + 1½ T.
Tartrate or phosphate	2½ t.	Chocolate	3 sq.
Or S. A. S.	1¾ t.	Vanilla	1 t.
Sugar	1¼ c. — 2½ t.		

3-Egg Chocolate Cake

Cake flour	3 c.	Fat	8 T. — ¼ t.
Salt	1 t.	Eggs	3
Baking powder—		Milk	1 c. + 1½ T.
Tartrate or phosphate	2 t.	Chocolate	3 sq.
Or S. A. S.	1⅜ t.	Vanilla	1 t.
Sugar	1¼ c. + ¾ t.		

4-Egg Chocolate Cake

Cake flour	3 c.	Fat	11 T. — ¼ t.
Salt	1 t.	Eggs	4
Baking powder—		Milk	¾ c. + 1½ T.
Tartrate or phosphate	1½ t.	Chocolate	3 sq.
Or S. A. S.	1 t.	Vanilla	1 t.
Sugar	1⅜ c. — 1¼ t.		

1-Egg Sweet-Milk Devil's-Food Cake

Cake flour	3 c.	Egg	1
Salt	1 t.	Milk	1½ c.
Baking powder—		Chocolate	4 sq.
Tartrate or phosphate	3 t.	Water (boiling)	1 c.
Or S. A. S.	2⅛ t.	Soda	1½ t.
Sugar	1⅜ c. — 1½ t.	Vanilla	1 t.
Fat	1 T. + 1¼ t.		

2-EGG SWEET-MILK DEVIL'S-FOOD CAKE

Cake flour	3 c.	Eggs	2
Salt	1 t.	Milk	1¼ c.
Baking powder—		Chocolate	4 sq.
Tartrate or phosphate	2½ t.	Water (boiling)	1 c.
Or S. A. S.	1¾ t.	Soda	1½ t.
Sugar	1¼ c. — 2½ t.	Vanilla	1 t.
Fat	4 T. + 1¼ t.		

3-EGG SWEET-MILK DEVIL'S-FOOD CAKE

Cake flour	3 c.	Eggs	3
Salt	1 t.	Milk	1 c.
Baking powder—		Chocolate	4 sq.
Tartrate or phosphate	2 t.	Water (boiling)	1 c.
Or S. A. S.	1⅜ t.	Soda	1½ t.
Sugar	1¼ c. + ¾ t.	Vanilla	1 t.
Fat	7 T. + 1¼ t.		

4-EGG SWEET-MILK DEVIL'S-FOOD CAKE

Cake flour	3 c.	Eggs	4
Salt	1 t.	Milk	¾ c.
Baking powder—		Chocolate	4 sq.
Tartrate or phosphate	1½ t.	Water (boiling)	1 c.
Or S. A. S.	1 t.	Soda	1½ t.
Sugar	1⅜ c. — 1¼ t.	Vanilla	1 t.
Fat	10 T. + ¼ t.		

1-EGG SOUR-MILK DEVIL'S-FOOD CAKE

Cake flour	3 c.	Sour milk	1¾ c.
Salt	1 t.	Chocolate	4 sq.
Sugar	1⅜ c. — 1½ t.	Water (boiling)	1 c.
Fat	1 T. + 1¼ t.	Soda	2½ t.
Egg	1	Vanilla	1 t.

2-EGG SOUR-MILK DEVIL'S-FOOD CAKE

Cake flour	3 c.	Sour milk	1½ c.
Salt	1 t.	Chocolate	4 sq.
Sugar	1¼ c. — 2½ t.	Water (boiling)	1 c.
Fat	4 T. + 1¼ t.	Soda	2¼ t.
Eggs	2	Vanilla	1 t.

3-EGG SOUR-MILK DEVIL'S-FOOD CAKE

Cake flour	3 c.	Sour milk	1¼ c.
Salt	1 t.	Chocolate	4 sq.
Sugar	1¼ c. + ¾ t.	Water (boiling)	1 c.
Fat	7 T. + 1¼ t.	Soda	2 t.
Eggs	3	Vanilla	1 t.

4-EGG SOUR-MILK DEVIL'S-FOOD CAKE

Cake flour	3 c.	Sour milk	1 c.
Salt	1 t.	Chocolate	4 sq.
Sugar	1⅜ c. — 1¼ t.	Water (boiling)	1 c.
Fat	10 T. + 1¼ t.	Soda	1¾ t.
Eggs	4	Vanilla	1 t.

SWEET-MILK SPICE CAKE

Use the corresponding foundation butter-cake recipe and add 5 teaspoons of either spice mixture.

1-EGG SOUR-MILK SPICE CAKE

Cake flour	3 c.	Egg	1
Salt	1 t.	Sour milk	1¾ c.
Sugar	1⅜ c. — 1½ t.	Soda	1 t.
Fat	3 T. + 1¼ t.	Spice	5 t.

2-EGG SOUR-MILK SPICE CAKE

Cake flour	3 c.	Eggs	2
Salt	1 t.	Sour milk	1½ c.
Sugar	1¼ c. — 2½ t.	Soda	¾ t.
Fat	6 T. + 1¼ t.	Spice	5 t.

3-EGG SOUR-MILK SPICE CAKE

Cake flour	3 c.	Eggs	3
Salt	1 t.	Sour milk	1¼ c.
Sugar	1¼ c. + ¾ t.	Soda	½ t.
Fat	9 T. + 1¼ t.	Spice	5 t.

4-EGG SOUR-MILK SPICE CAKE

Cake flour	3 c.	Eggs	4
Salt	1 t.	Sour milk	1 c.
Sugar	1⅜ c. — 1¼ t.	Soda	¼ t.
Fat	12 T. + 1¼ t.	Spice	5 t.

2-EGG-WHITE WHITE CAKE

Cake flour	3 c.	Sugar	1⅜ c. — 1½ t.
Salt	1 t.	Fat	3 T. + 2¾ t.
Baking powder—		Egg-whites	2
Tartrate or phosphate	3 t. or 2¾ t.	Milk	1½ c.
Or S. A. S.	2⅛ t. or 1⅞ t.	Flavoring	1 t.

4-EGG-WHITE WHITE CAKE

Cake flour	3 c.	Sugar	1¼ c. — 2½ t.
Salt	1 t.	Fat	7 T. + 1¼ t.
Baking powder—		Egg-whites	4
Tartrate or phosphate	2½ t. or 2 t.	Milk	1¼ c.
Or S. A. S.	1¾ t. or 1¼ t.	Flavoring	1 t.

6-EGG-WHITE WHITE CAKE

Cake flour	3 c.	Sugar	1¼ c. + ¾ t.
Salt	1 t.	Fat	10 T. + 2¾ t.
Baking powder—		Egg-whites	6
Tartrate or phosphate	2 t. or 1¼ t.	Milk	1 c.
Or S. A. S.	1⅜ t. or ⅝ t.	Flavoring	1 t.

8-EGG-WHITE WHITE CAKE

Cake flour	3 c.	Sugar	1⅜ c. — 1¼ t.
Salt	1 t.	Fat	14 T. + 1¼ t.
Baking powder—		Egg-whites	8
Tartrate or phosphate	1½ t. or ½ t.	Milk	¾ c.
Or S. A. S.	1 t. or none	Flavoring	1 t.

2-Egg-Yolk Gold Cake

Cake flour	3 c.	Sugar	1⅜ c. — 1½ t.
Salt	1 t.	Fat	3 T. — ¼ t.
Baking powder—		Egg-yolks	2
Tartrate or phosphate	3 t. or 3¼ t.	Milk	1½ c. + 1⅓ T.
Or S. A. S.	2⅛ t. or 2⅜ t.	Flavoring	1 t.

4-Egg-Yolk Gold Cake

Cake flour	3 c.	Sugar	1¼ c. — 2½ t.
Salt	1 t.	Fat	5 T. + 1¼ t.
Baking powder—		Egg-yolks	4
Tartrate or phosphate	2½ t. or 3 t.	Milk	1¼ c. + 2⅓ T.
Or S. A. S.	1¾ t. or 2¼ t.	Flavoring	1 t.

6-Egg-Yolk Gold Cake

Cake flour	3 c.	Sugar	1¼ c. + ¾ t.
Salt	1 t.	Fat	8 T. — ¼ t.
Baking powder—		Egg-yolks	6
Tartrate or phosphate	2 t. or 2¾ t.	Milk	1¼ c.
Or S. A. S.	1⅜ t. or 2⅛ t.	Flavoring	1 t.

8-Egg-Yolk Gold Cake

Cake flour	3 c.	Sugar	1⅜ c. — 1¼ t.
Salt	1 t.	Fat	10 T. + 1¼ t.
Baking powder—		Egg-yolks	8
Tartrate or phosphate	1½ t. or 2½ t.	Milk	1 c. + 1⅓ T.
Or S. A. S.	1 t. or 2 t.	Flavoring	1 t.

Angel-Food Cake

Cake flour	1 c. + 1 T.	Cream of tartar	1⅝ t.
Sugar	1 c. + 1¼ t.	Flavoring	1½ t.
Egg-whites	1⅜ c.	Bake	350° F.
Salt	¼ t.	Time	50 min.

Sponge Cake

Cake flour	1 c. + 1 T.	Salt	¼ t.
Sugar	⅞ c. — 1¼ t.	Lemon juice	3 T.
Egg-whites	6	Bake	350° F.
Egg-yolks	6	Time	1 hour

9,820-Feet Recipes

For directions see pages 139 to 144.

Popovers

Flour	1 c.	Milk	1 c. + 1⅔ T.
Salt	¼ t.	Butter	½ t.
Eggs	3		

Baking-Powder Biscuits

Flour—		Baking powder—	
Bread	2 c.	Tartrate or phosphate	3¼ t.
Or pastry	2⅔ c.	Or S. A. S.	2¼ t.
Salt	½ t.	Fat	3 T. + ½ t.
		Milk	¾ c.

MUFFINS

Flour—		Baking powder—	
Bread	2 c.	Tartrate or phosphate	3¼ t.
Or pastry	2⅔ c.	Or S. A. S.	2¼ t.
Salt	½ t.	Fat	2 to 3 T.
Sugar	2 to 2⅛ T.	Egg	1
		Milk	1 c.

1-EGG FOUNDATION BUTTER CAKE

Cake flour	3 c.	Fat	3 T. + ½ t.
Salt	1 t.	Egg	1
Baking powder—		Milk	1½ c.
Tartrate or phosphate	2⅝ t.	Flavoring	1 t.
Or S. A. S.	1⅞ t.	Bake	400° F.
Sugar	1¼ c. + 1¾ t.	Time	20 to 30 min.

2-EGG FOUNDATION BUTTER CAKE

Cake flour	3 c.	Fat	6 T. + ½ t.
Salt	1 t.	Eggs	2
Baking powder—		Milk	1¼ c.
Tartrate or phosphate	2⅛ t.	Flavoring	1 t.
Or S. A. S.	1½ t.	Bake	395° F.
Sugar	1⅓ c. + 1¾ t.	Time	20 to 30 min.

3-EGG FOUNDATION BUTTER CAKE

Cake flour	3 c.	Fat	9 T. + ½ t.
Salt	1 t.	Eggs	3
Baking powder—		Milk	1 c.
Tartrate or phosphate	1⅝ t.	Flavoring	1 t.
Or S. A. S.	1⅛ t.	Bake	390° F.
Sugar	1¼ c. − ½ T.	Time	25 to 30 min.

4-EGG FOUNDATION BUTTER CAKE

Cake flour	3 c.	Sugar	1¼ c. + 2½ t.
Salt	1 t.	Fat	12 T. + ½ t.
Baking powder—		Eggs	4
Tartrate or phosphate	1⅛ t.	Milk	¾ c.
Or S. A. S.	¾ t.	Flavoring	1 t.
		Bake	385° F.
		Time	25 to 30 min.

1-EGG CHOCOLATE CAKE

Cake flour	3 c.	Fat	1 T. + 2 t.
Salt	1 t.	Egg	1
Baking powder—		Milk	1½ c. + 1½ T.
Tartrate or phosphate	2⅝ t.	Chocolate	3 sq.
Or S. A. S.	1⅞ t.	Vanilla	1 t.
Sugar	1¼ c. + 1¾ t.		

2-EGG CHOCOLATE CAKE

Cake flour	3 c.	Fat	4 T. + 2 t.
Salt	1 t.	Eggs	2
Baking powder—		Milk	1¼ c. + 1½ T.
Tartrate or phosphate	2⅛ t.	Chocolate	3 sq.
Or S. A. S.	1½ t.	Vanilla	1 t.
Sugar	1⅓ c. + 1¾ t.		

3-Egg Chocolate Cake

Cake flour	3 c.	Fat	7 T. + 1/2 t.
Salt	1 t.	Eggs	3
Baking powder—		Milk	1 c. + 1 1/2 T.
Tartrate or phosphate	1 5/8 t.	Chocolate	3 sq.
Or S. A. S.	1 1/8 t.	Vanilla	1 t.
Sugar	1 1/4 c. − 1/2 T.		

4-Egg Chocolate Cake

Cake flour	3 c.	Fat	10 T. + 2 t.
Salt	1 t.	Eggs	4
Baking powder—		Milk	3/4 c. + 1 1/2 T.
Tartrate or phosphate	1 1/8 t.	Chocolate	3 sq.
Or S. A. S.	3/4 t.	Vanilla	1 t.
Sugar	1 1/4 c. + 2 1/2 t.		

1-Egg Sweet-Milk Devil's-Food Cake

Cake flour	3 c.	Egg	1
Salt	1 t.	Milk	1 1/2 c.
Baking powder—		Chocolate	4 sq.
Tartrate or phosphate	2 5/8 t.	Water (boiling)	1 c.
Or S. A. S.	1 7/8 t.	Soda	1 1/2 t.
Sugar	1 1/4 c. + 1 3/4 t.	Vanilla	1 t.
Fat	1 T. + 1/2 t.		

2-Egg Sweet-Milk Devil's-Food Cake

Cake flour	3 c.	Eggs	2
Salt	1 t.	Milk	1 1/4 c.
Baking powder—		Chocolate	4 sq.
Tartrate or phosphate	2 1/8 t.	Water (boiling)	1 c.
Or S. A. S.	1 1/2 t.	Soda	1 1/2 t.
Sugar	1 1/8 c. + 1 3/4 t.	Vanilla	1 t.
Fat	4 T. + 1/2 t.		

3-Egg Sweet-Milk Devil's-Food Cake

Cake flour	3 c.	Eggs	3
Salt	1 t.	Milk	1 c.
Baking powder—		Chocolate	4 sq.
Tartrate or phosphate	1 5/8 t.	Water (boiling)	1 c.
Or S. A. S.	1 1/8 t.	Soda	1 1/2 t.
Sugar	1 1/4 c. − 1/2 T.	Vanilla	1 t.
Fat	7 T. + 1/2 t.		

4-Egg Sweet-Milk Devil's-Food Cake

Cake flour	3 c.	Eggs	4
Salt	1 t.	Milk	3/4 c.
Baking powder—		Chocolate	4 sq.
Tartrate or phosphate	1 1/8 t.	Water (boiling)	1 c.
Or S. A. S.	3/4 t.	Soda	1 1/2 t.
Sugar	1 1/4 c. + 2 1/2 t.	Vanilla	1 t.
Fat	10 T. + 1/2 t.		

1-Egg Sour-Milk Devil's-Food Cake

Cake flour	3 c.	Sour milk	1 3/4 c.
Salt	1 t.	Chocolate	4 sq.
Sugar	1 1/4 c. + 1 3/4 t.	Water (boiling)	1 c.
Fat	1 T. + 1/2 t.	Soda	2 1/2 t.
Egg	1	Vanilla	1 t.

2-Egg Sour-Milk Devil's-Food Cake

Cake flour	3 c.	Sour milk	$1\frac{1}{2}$ c.
Salt	1 t.	Chocolate	4 sq.
Sugar	$1\frac{1}{8}$ c. + $1\frac{3}{4}$ t.	Water (boiling)	1 c.
Fat	4 T. + $\frac{1}{2}$ t.	Soda	$2\frac{1}{4}$ t.
Eggs	2	Vanilla	1 t.

3-Egg Sour-Milk Devil's-Food Cake

Cake flour	3 c.	Sour milk	$1\frac{1}{4}$ c.
Salt	1 t.	Chocolate	4 sq.
Sugar	$1\frac{1}{4}$ c. — $\frac{1}{2}$ T.	Water (boiling)	1 c.
Fat	7 T. + $\frac{1}{2}$ t.	Soda	2 t.
Eggs	3	Vanilla	1 t.

4-Egg Sour-Milk Devil's-Food Cake

Cake flour	3 c.	Sour milk	1 c.
Salt	1 t.	Chocolate	4 sq.
Sugar	$1\frac{1}{4}$ c. + $2\frac{1}{2}$ t.	Water (boiling)	1 c.
Fat	10 T. + $\frac{1}{2}$ t.	Soda	$1\frac{3}{4}$ t.
Eggs	4	Vanilla	1 t.

Sweet-Milk Spice Cake

Use the corresponding foundation butter-cake recipe and add 5 teaspoons of either spice mixture.

1-Egg Sour-Milk Spice Cake

Cake flour	3 c.	Egg	1
Salt	1 t.	Sour milk	$1\frac{3}{4}$ c.
Sugar	$1\frac{1}{4}$ c. + $1\frac{3}{4}$ t.	Soda	1 t.
Fat	3 T. + $\frac{1}{2}$ t.	Spice	5 t.

2-Egg Sour-Milk Spice Cake

Cake flour	3 c.	Eggs	2
Salt	1 t.	Sour milk	$1\frac{1}{2}$ c.
Sugar	$1\frac{1}{8}$ c. + $1\frac{3}{4}$ t.	Soda	$\frac{3}{4}$ t.
Fat	6 T. + $\frac{1}{2}$ t.	Spice	5 t.

3-Egg Sour-Milk Spice Cake

Cake flour	3 c.	Eggs	3
Salt	1 t.	Sour milk	$1\frac{1}{4}$ c.
Sugar	$1\frac{1}{4}$ c. — $\frac{1}{2}$ T.	Soda	$\frac{1}{2}$ t.
Fat	9 T. + $\frac{1}{2}$ t.	Spice	5 t.

4-Egg Sour-Milk Spice Cake

Cake flour	3 c.	Eggs	4
Salt	1 t.	Sour milk	1 c.
Sugar	$1\frac{1}{4}$ c. + $2\frac{1}{2}$ t.	Soda	$\frac{1}{4}$ t.
Fat	12 T. + $\frac{1}{2}$ t.	Spice	5 t.

2-Egg-White White Cake

Cake flour	3 c.	Sugar	$1\frac{1}{4}$ c. + $1\frac{3}{4}$ t.
Salt	1 t.	Fat	3 T. + 2 t.
Baking powder—		Egg-whites	2
Tartrate or phosphate	$2\frac{5}{8}$ t. or $2\frac{3}{8}$ t.	Milk	$1\frac{1}{2}$ c.
Or S. A. S.	$1\frac{7}{8}$ t. or $1\frac{5}{8}$ t.	Flavoring	1 t.

4-Egg-White White Cake

Cake flour	3 c.	Sugar	$1\frac{1}{8}$ c. + $1\frac{3}{4}$ t.
Salt	1 t.	Fat	7 T. + $\frac{1}{2}$ t.
Baking powder—		Egg-whites	4
Tartrate or phosphate	$2\frac{1}{8}$ or $1\frac{5}{8}$ t.	Milk	$1\frac{1}{4}$ c.
Or S. A. S.	$1\frac{1}{2}$ t. or 1 t.	Flavoring	1 t.

6-Egg-White White Cake

Cake flour	3 c.	Sugar	1¼ c. — ½ T.
Salt	1 t.	Fat	10 T. + 2 t.
Baking powder—		Egg-whites	6
Tartrate or phosphate	1⅝ t. or ⅞ t.	Milk	1 c.
Or S. A. S.	1⅛ t. or ⅜ t.	Flavoring	1 t.

8-Egg-White White Cake

Cake flour	3 c.	Sugar	1¼ c. + 2½ t.
Salt	1 t.	Fat	14 T. + ½ t.
Baking powder—		Egg-whites	8
Tartrate or phosphate	1⅛ t. or ⅛ t.	Milk	¾ c.
Or S. A. S.	¾ t. or none	Flavoring	1 t.

2-Egg-Yolk Gold Cake

Cake flour	3 c.	Sugar	1¼ c. + 1¾ t.
Salt	1 t.	Fat	2 T. + 2 t.
Baking powder—		Egg-yolks	2
Tartrate or phosphate	2⅝ t. or 2⅞ t.	Milk	1½ c. + 1⅓ T.
Or S. A. S.	1⅞ t. or 2⅛ t.	Flavoring	1 t.

4-Egg-Yolk Gold Cake

Cake flour	3 c.	Sugar	1⅛ c. + 1¾ t.
Salt	1 t.	Fat	5 T. + ½ t.
Baking powder—		Egg-yolks	4
Tartrate or phosphate	2⅛ t. or 2⅝ t.	Milk	1¼ c. + 2⅔ T.
Or S. A. S.	1½ t. or 2 t.	Flavoring	1 t.

6-Egg-Yolk Gold Cake

Cake flour	3 c.	Sugar	1¼ c. — ½ T.
Salt	1 t.	Fat	7 T. + 2 t.
Baking powder—		Egg-yolks	6
Tartrate or phosphate	1⅝ t. or 2⅜ t.	Milk	1¼ c.
Or S. A. S.	1⅛ t. or 1⅞ t.	Flavoring	1 t.

8-Egg-Yolk Gold Cake

Cake flour	3 c.	Sugar	1¼ c. + 2½ t.
Salt	1 t.	Fat	10 T. + ½ t.
Baking powder—		Egg-yolks	8
Tartrate or phosphate	1⅛ t. or 2⅛ t.	Milk	1 c. + 1⅓ T.
Or S. A. S.	¾ t. or 1¾ t.	Flavoring	1 t.

Angel Food

Cake flour	1 c. + 1½ T.	Cream of tartar	1¾ t.
Sugar	1 c. — 2½ t.	Flavoring	1½ t.
Egg-whites	1⅜ c.	Bake	350° F. to 375° F.
Salt	¼ t.	Time	50 min.

Sponge Cake

Cake flour	1 c. + 1½ T.	Salt	¼ t.
Sugar	¾ c. + 2½ t.	Lemon juice	3 T.
Egg-whites	6	Bake	350° F. to 375° F.
Egg-yolks	6	Time	1 hour

11,180-Feet Recipes

For directions see pages 139 to 144.

Popovers

Flour	1 c.	Milk	1 c. + 2 T.
Salt	¼ t.	Butter	none
Eggs	3		

Baking-Powder Biscuits

Flour—		Baking powder—	
Bread	2 c.	Tartrate or phosphate	3 t.
Or pastry	2⅔ c.	Or S. A. S.	2¼ t.
Salt	½ t.	Fat	3 T.
		Milk	¾ c.

Muffins

Flour—			
Bread	2 c.	Fat	2 to 3 T.
Or pastry	2⅔ c.	Egg	1
Salt	½ t.	Milk	1 c.
Baking powder—		Sugar	2 T.
Tartrate or phosphate	3¼ t.		
Or S. A. S.	2¼ t.		

1-Egg Foundation Butter Cake

Cake flour	3 c.	Fat	3 T.
Salt	1 t.	Egg	1
Baking powder—		Milk	1½ c.
Tartrate or phosphate	2¼ t.	Flavoring	1 t.
Or S. A. S.	1⅝ t.	Bake	400° F.
Sugar	1¼ c.	Time	20 to 30 min.

2-Egg Foundation Butter Cake

Cake flour	3 c.	Fat	6 T.
Salt	1 t.	Eggs	2
Baking powder—		Milk	1¼ c.
Tartrate or phosphate	1¾ t.	Flavoring	1 t.
Or S. A. S.	1¼ t.	Bake	395° F.
Sugar	1⅛ c.	Time	20 to 30 min.

3-Egg Foundation Butter Cake

Cake flour	3 c.	Fat	9 T.
Salt	1 t.	Eggs	3
Baking powder—		Milk	1 c.
Tartrate or phosphate	1¼ t.	Flavoring	1 t.
Or S. A. S.	⅞ t.	Bake	390° F.
Sugar	1¼ c. — 1 T.	Time	25 to 30 min.

4-Egg Foundation Butter Cake

Cake flour	3 c.	Fat	12 T.
Salt	1 t.	Eggs	4
Baking powder—		Milk	¾ c.
Tartrate or phosphate	¾ t.	Flavoring	1 t.
Or S. A. S.	½ t.	Bake	385° F.
Sugar	1¼ c.	Time	25 to 30 min.

1-Egg Chocolate Cake

Cake flour	3 c.	Fat	1½ T.
Salt	1 t.	Egg	1
Baking powder—		Milk	1½ c. + 1½ T.
Tartrate or phosphate	2¼ t.	Chocolate	3 sq.
Or S. A. S.	1⅝ t.	Vanilla	1 t.
Sugar	1¼ c.		

2-Egg Chocolate Cake

Cake flour	3 c.	Fat	4½ T.
Salt	1 t.	Eggs	2
Baking powder—		Milk	1¼ c. + 1½ T.
Tartrate or phosphate	1¾ t.	Chocolate	3 sq.
Or S. A. S.	1¼ t.	Vanilla	1 t.
Sugar	1⅛ c.		

3-Egg Chocolate Cake

Cake flour	3 c.	Fat	7½ T.
Salt	1 t.	Eggs	3
Baking powder—		Milk	1 c. + 1½ T.
Tartrate or phosphate	1¼ t.	Chocolate	3 sq.
Or S. A. S.	⅞ t.	Vanilla	1 t.
Sugar	1¼ c. — 1 T.		

4-Egg Chocolate Cake

Cake flour	3 c.	Fat	10½ T.
Salt	1 t.	Eggs	4
Baking powder—		Milk	¾ c. + 1½ T.
Tartrate or phosphate	¾ t.	Chocolate	3 sq.
Or S. A. S.	½ t.	Vanilla	1 t.
Sugar	1¼ c.		

1-Egg Sweet-Milk Devil's-Food Cake

Cake flour	3 c.	Egg	1
Salt	1 t.	Milk	1½ c.
Baking powder—		Chocolate	4 sq.
Tartrate or phosphate	2¼ t.	Water (boiling)	1 c.
Or S. A. S.	1⅝ t.	Soda	1½ t.
Sugar	1¼ c.	Vanilla	1 t.
Fat	1 T.		

2-Egg Sweet-Milk Devil's-Food Cake

Cake flour	3 c.	Eggs	2
Salt	1 t.	Milk	1¼ c.
Baking powder—		Chocolate	4 sq.
Tartrate or phosphate	1¾ t.	Water (boiling)	1 c.
Or S. A. S.	1¼ t.	Soda	1½ t.
Sugar	1⅛ c.	Vanilla	1 t.
Fat	4 T.		

3-Egg Sweet-Milk Devil's-Food Cake

Cake flour	3 c.	Eggs	3
Salt	1 t.	Milk	1 c.
Baking powder—		Chocolate	4 sq.
Tartrate or phosphate	1¼ t.	Water (boiling)	1 c.
Or S. A. S.	⅞ t.	Soda	1½ t.
Sugar	1¼ c. — 1 T.	Vanilla	1 t.
Fat	7 T.		

4-Egg Sweet-Milk Devil's-Food Cake

Cake flour	3 c.	Eggs	4
Salt	1 t.	Milk	¾ c.
Baking powder—		Chocolate	4 sq.
Tartrate or phosphate	¾ t.	Water (boiling)	1 c.
Or S. A. S.	½ t.	Soda	1½ t.
Sugar	1¼ c.	Vanilla	1 t.
Fat	10 T.		

1-Egg Sour-Milk Devil's-Food Cake

Cake flour	3 c.	Sour milk	1¾ c.
Salt	1 t.	Chocolate	4 sq.
Sugar	1¼ c.	Water (boiling)	1 c.
Fat	1 T.	Soda	2½ t.
Egg	1	Vanilla	1 t.

2-Egg Sour-Milk Devil's-Food Cake

Cake flour	3 c.	Sour milk	1½ c.
Salt	1 t.	Chocolate	4 sq.
Sugar	1⅛ c.	Water (boiling)	1 c.
Fat	4 T.	Soda	2¼ t.
Eggs	2	Vanilla	1 t.

3-Egg Sour-Milk Devil's-Food Cake

Cake flour	3 c.	Sour milk	1¼ c.
Salt	1 t.	Chocolate	4 sq.
Sugar	1¼ c. — 1 T.	Water (boiling)	1 c.
Fat	7 T.	Soda	2 t.
Eggs	3	Vanilla	1 t.

4-Egg Sour-Milk Devil's-Food Cake

Cake flour	3 c.	Sour milk	1 c.
Salt	1 t.	Chocolate	4 sq.
Sugar	1¼ c.	Water (boiling)	1 c.
Fat	10 T.	Soda	1¾ t.
Eggs	4	Vanilla	1 t.

Sweet-Milk Spice Cake

Use the corresponding foundation butter-cake recipe and add 5 teaspoons of either spice mixture.

1-Egg Sour-Milk Spice Cake

Cake flour	3 c.	Egg	1
Salt	1 t.	Sour milk	1¾ c.
Sugar	1¼ c.	Soda	1 t.
Fat	3 T.	Spice	5 t.

2-Egg Sour-Milk Spice Cake

Cake flour	3 c.	Eggs	2
Salt	1 t.	Sour milk	1½ c.
Sugar	1⅛ c.	Soda	¾ t.
Fat	6 T.	Spice	5 t.

3-Egg Sour-Milk Spice Cake

Cake flour	3 c.	Eggs	3
Salt	1 t.	Sour milk	1¼ c.
Sugar	1¼ c. — 1 T.	Soda	½ t.
Fat	9 T.	Spice	5 t.

4-Egg Sour-Milk Spice Cake

Cake flour	3 c.	Eggs	4
Salt	1 t.	Sour milk	1 c.
Sugar	1¼ c.	Soda	¼ t.
Fat	12 T.	Spice	5 t.

2-Egg-White White Cake

Cake flour	3 c.	Fat	3 T. + 1½ t.
Salt	1 t.	Egg-whites	2
Baking powder—		Milk	1½ c.
Tartrate or phosphate	2¼ t. or 2 t.	Flavoring	1 t.
Or S. A. S	1⅝ t. or 1⅜ t.		
Sugar	1¼ c.		

4-Egg-White White Cake

Cake flour	3 c.	Sugar	1⅛ c.
Salt	1 t.	Fat	7 T.
Baking powder—		Egg-whites	4
Tartrate or phosphate	1¾ t. or 1¼ t.	Milk	1¼ c.
Or S. A. S	1¼ t. or ¾ t.	Flavoring	1 t.

6-Egg-White White Cake

Cake flour	3 c.	Sugar	1¼ c. — 1 T.
Salt	1 t.	Fat	10½ T.
Baking powder—		Egg-whites	6
Tartrate or phosphate	1¼ t. or ½ t.	Milk	1 c.
Or S. A. S	⅞ t. or ⅛ t.	Flavoring	1 t.

8-Egg-White White Cake

Cake flour	3 c.	Sugar	1¼ c.
Salt	1 t.	Fat	14 T.
Baking powder—		Egg-whites	8
Tartrate or phosphate	¾ t. or none	Milk	¾ c.
Or S. A. S	½ t. or none	Flavoring	1 t.

2-Egg-Yolk Gold Cake

Cake flour	3 c.	Sugar	1¼ c.
Salt	1 t.	Fat	2 T. + 1½ t.
Baking powder—		Egg-yolks	2
Tartrate or phosphate	2¼ t. or 2½ t.	Milk	1½ c. + 1⅓ T.
Or S. A. S	1⅝ t. or 1⅞ t.	Flavoring	1 t.

4-Egg-Yolk Gold Cake

Cake flour	3 c.	Sugar	1⅛ c.
Salt	1 t.	Fat	5 T.
Baking powder—		Egg-yolks	4
Tartrate or phosphate	1¾ t. or 2¼ t.	Milk	1¼ c. + 2⅔ T.
Or S. A. S	1¼ t. or 2¾ t.	Flavoring	1 t.

6-Egg-Yolk Gold Cake

Cake flour	3 c.	Sugar	1¼ c. — 1 T.
Salt	1 t.	Fat	7 T. + 1½ t.
Baking powder—		Egg-yolks	6
Tartrate or phosphate	1¼ t. or 2 t.	Milk	1¼ c.
Or S. A. S	⅞ t. or 1⅝ t.	Flavoring	1 t.

8-Egg-Yolk Gold Cake

Cake flour	3 c.	Sugar	1¼ c.
Salt	1 t.	Fat	10 T.
Baking powder—		Egg-yolks	8
Tartrate or phosphate	¾ t. or 1¾ t.	Milk	1 c. + 1⅓ T.
Or S. A. S.	½ t. or 1½ t.	Flavoring	1 t.

Angel Food

Cake flour	1 c. + 2 T.	Cream of tartar	1¾ t.
Sugar	⅞ c.	Flavoring	1½ t.
Egg-whites	1⅜ c.	Bake	350° F. to 375° F.
Salt	¼ t.	Time	50 min.

Sponge Cake

Cake flour	1 c. + 2 T.	Salt	¼ t.
Sugar	¾ c.	Lemon juice	3 T.
Egg-whites	6	Bake	350° F. to 375° F.
Egg-yolks	6	Time	1 hour