TM 10-410

WAR DEPARTMENT TECHNICAL MANUAL

THE ARMY BAKER

WAR DEPARTMENT • APRIL 1945

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This manual supersedes TM 10-410, 1 July 1942, including C 1, 3 December 1942; C 2, 26 March 1943; and Supplement, Rope and Mold in Baked Products, 30 April 1943.

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United States Government Printing Office

Washington : 1945

WAR DEPARTMENT
Washington 25, D. C., 18 April 1945

TM 10–410, The Army Baker, is published for the information and guidance of all concerned.

[AG 300.7 (19 Feb 45)]

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G. C. MARSHALL
Chief of Staff

OFFICIAL:

J. A. ULIO,
Major General
The Adjutant General

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Refer to FM 21-6 for explanation of distribution formula.

FOREWORD

The American soldier expects to have white, yeast-leavened bread served with his meals. To provide this bread the Army baker must be able to produce a good loaf of bread whether he finds himself in a modernly equipped garrison bakery or in a theater of operations using improvised troughs and ovens. That is his mission and the end to which he is trained.

This manual is published to help the Army baker accomplish his mission. It can serve both as a textbook for the training of a baker and as a handy reference book to enable the baker to improve his product. To be skilled in his craft, a baker must know the nature and function of the bread ingredients, the processes involved in the manufacture of bread, the standard formulas and how to use them, how to correct bread faults, and how to prevent rope and mold. This manual includes the basic information on all these points.

In order to standardize equipment and training, the Army has adopted six types of bread. These standard types of bread are:

a. Garrison Bread. This bread is baked in individual 20-ounce loaves. It is similar in appearance to commercial bread.

b. Field Garrison (sheet) Bread. This bread is called "sheet bread" because the loaves are placed in a ration pan and baked in a 10- or 12-pound sheet. The 10-pound sheet is made up of five 2-pound loaves, while six 2-pound loaves are baked in the 12-pound sheet. The loaves are easily separated, but lack the side crust found in garrison bread. This type of loaf is primarily for field bakeries.

c. Field Bread. This bread is baked in a 4-pound round loaf with a heavy crust. To assure this heavy crust the formula contains little sugar and shortening. As a result, the bread keeps well and the rough handling necessary in field distribution does not damage the loaf. Field bread may be either panned two loaves to the ration pan or hearth baked.

d. Whole-Wheat Bread. Sometimes in fixed installations whole-wheat bread is baked to give variety to the bread diet. Some people prefer its distinctive taste.

e. Raisin Bread. Raisin bread is also baked occasionally to give variety to the bread diet. In fixed installations, raisin bread is commonly supplied about once each week.

f. Rye Bread. Rye bread provides a third variation in bread diet. The loaves of rye bread are smaller and more compact, and have a darker crumb than white bread. Rye bread is rarely baked in the field.

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CHAPTER I. INGREDIENTS.

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CHAPTER I

INGREDIENTS

Section I. GENERAL

1. Why Study Ingredients?

The skilled baker must have a knowledge of the nature, characteristics, and functions of the ingredients needed for yeast-leavened bread. Breadmaking is more than mixing up the ingredients, putting the resulting mass in a pan, and making it. The chemical changes that take place during fermentation, the effects of temperature and moisture upon the process, and the method of handling the dough mass all contribute to the quality of the bread. Slight changes in the amounts of the ingredients or in the bread-making process also affect the quality of the bread. If the baker understands the part each ingredient plays in the finished product, he is able to improve bread quality by making the proper changes.

2. Basic and Enriching Ingredients

a. Bread ingredients are divided into two groups —basic ingredients and enriching ingredients.

b. The basic ingredients are those which must be available if yeast-leavened bread is to be manufactured. These "minimum essentials" are:

(1) Flour.
(2) Water.
(3) Yeast.
(4) Salt.

c. While bread can be manufactured by using only the basic ingredients, enriching ingredients must be used if the loaf is to meet Army standards. The use of this group of ingredients results in bread with improved appearance, better keeping qualities, tender crumb, and higher nutritional values. These additional ingredients include the following:

(1) Sugar.
(2) Shortening.
(3) Milk.
(4) Malt.

Section II. FLOUR

3. Wheat and Flour

a. Superior Qualities of Wheat. Wheat flour is the only kind that, when used alone, will make satisfactory leavened bread. Other grains such as corn, rye, and barley, contain proteins, carbohydrates, fats, and minerals; but wheat flour is the only flour that contains the two proteins, gliadin and glutenin, in the proper proportion to form gluten when water is added to the flour. Gluten enables dough to hold the leavening gas that gives bread its characteristic cell structure and lightness.

b. Structure of Wheat. The grain of wheat consists of three main parts—the bran, the germ, and the endosperm. (See fig. 1.) The bran is composed of the outer coats which protect the inner parts during growth, threshing, and storage. At one end of the grain is the germ which, if the grain were planted, would grow into a wheat plant. The inner portion is the endosperm from which white flour is made. This comprises about 85 percent of the wheat kernel and is rich in starch and gluten-forming proteins.

c. Whole-Wheat Flour. When the entire grain of wheat is ground into flour, whole-wheat flour is produced. Bread made from this flour is brown in color and, compared to white bread, is high in mineral and roughage content. To make a somewhat lighter loaf (both in texture and color) white flour is blended with the whole-wheat flour.

d. White Flour (enriched). If the bran and germ are removed from the flour during the milling process (par. 5), white flour is produced. It is derived almost entirely from the endosperm. White flour makes a much better quality loaf of bread than whole wheat since the particles of bran in whole-wheat flour cut the gluten. This action allows the gas to escape and results in a smaller "heavier" loaf. However, in removing the bran layers from the

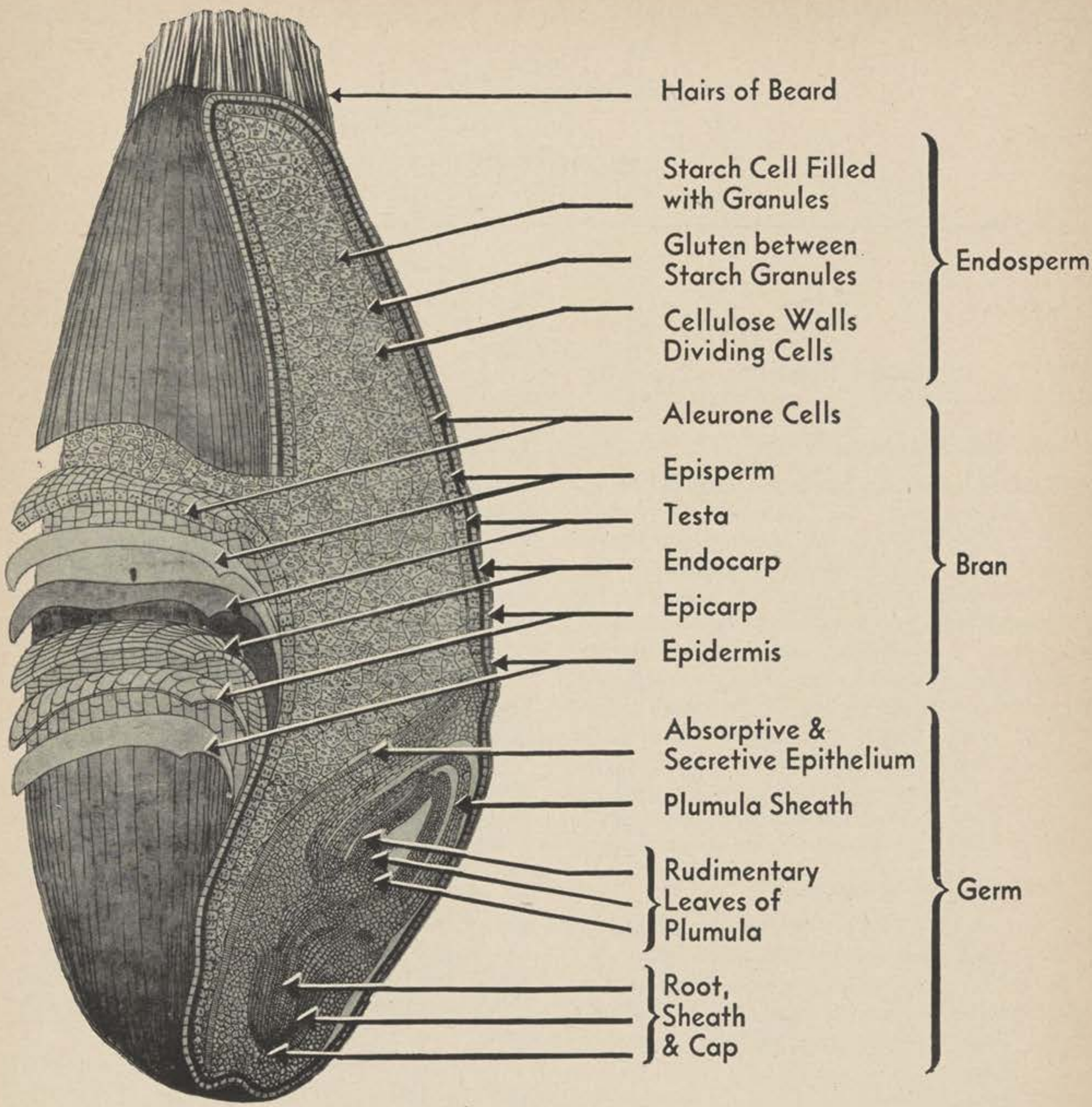


Figure 1. Structure of the wheat grain. The interior of a grain of wheat is protected by the bran coats.

grain, part of the minerals and vitamins found in wheat are also removed and the flour must be enriched (par. 6c) in order to restore those nutritive substances. The Army buys only enriched white flour for issue in the United States and shipment overseas.

e. Rye Flour. Bread made from rye flour lacks gluten. The loaf is small in volume, soggy, compact, and unpalatable to the average American. To get a loaf with good volume, smooth porous texture, and the distinctive rye flavor, from 10 to 40 percent rye flour is blended with wheat flour. By this blending, the wheat flour provides the necessary gluten-forming proteins for a good loaf while the rye flour gives the product the rye color and taste. In the milling of rye flour three grades are produced:

(1) *White.* This flour is nearly white and, when blended with wheat flour, makes a light rye bread.

(2) *Dark.* Dark rye flour is very dark and has a "branny" taste. When a dark rye bread is desired, this flour is blended with wheat flour.

(3) *Medium.* Medium rye flour is a blend of

dark and white rye flours. It has the true rye taste and is the grade most commonly used in rye bread.

4. Classification of Wheat and Flour

a. Hardness and Softness of Wheat. The hardness or softness of wheat is determined by the character of the endosperm.

(1) *Hard wheat.* Hard-wheat kernels are darker in color than soft-wheat kernels and are difficult to cut or bite. Once cut, the surface of the endosperm is dark and vitreous. The starch is closely packed with the protein and is not evident.

(2) *Soft wheat.* Soft-wheat kernels are lighter in color, cut easily, and have an inner surface that is somewhat white and starchy.

b. U. S. Federal Classification of Wheat. The four classes of common wheat are as follows:

(1) *Hard spring wheat.* Varieties of hard wheat sown in the spring and harvested in the following fall.

(2) *Hard winter wheat.* Varieties of hard wheat sown in the fall and harvested the following summer.

(3) *Soft winter wheat.* Varieties of soft wheat sown in the fall and harvested the following summer.

(4) *Durum wheat.* Varieties of hard wheat sown in the spring and harvested in the following fall.

c. Classes of Flour Produced. From the classes of wheat listed above the following classes of flour are milled:

(1) *Hard spring-wheat flour.* This flour has all the characteristics of a hard-wheat flour (granular feel, rich creamy color, high content of gluten-forming proteins) and is excellent for use in bread making.

(2) *Hard winter-wheat flour.* This flour has good color, an excellent flavor, and produces a rather strong gluten. The gluten is not as strong as that of hard-spring-wheat flour.

(3) *Soft winter-wheat flour.* This flour is low in gluten content and is not desirable for bread making. It is white and has a soft fluffy texture and excellent flavor. It is particularly suitable for cakes and pastry products.

(4) *Durum-wheat flour.* This flour contains a large quantity of very hard and tough gluten which develops somewhat slowly in fermentation. The excessive hardness of the gluten makes durum flour unsatisfactory for bread making but it is used for manufacturing macaroni and spaghetti.

(5) *Blended flours.* Hard spring and hard winter flours are frequently blended together to combine the desirable features of the strong gluten in spring wheat with the characteristic flavor and color of the winter flour. Blends are also made up of hard- and soft-wheat flours to take advantage of the peculiarities of each type.

5. Milling of Wheat

a. Definition. Milling is the process by which the endosperm is separated from the bran and the germ and is ground into flour.

b. Preparation of Wheat for Milling. To maintain uniform quality in the flour, several different wheats are often blended together before the flour is milled. By this method the color, protein content, and baking quality of the flour are predetermined. After the blending is completed, all foreign matter must be removed from the wheat. Dirt, dust, chaff, weed seeds, shriveled wheat, and bits of metal are removed by air currents and sieves. Tempering the wheat by moistening it with water at a predetermined temperature is the final step in the preparation of the grain for milling. This toughens the bran so that it can be easily removed when broken into tiny pieces by the break rolls.

c. The Roller Milling Process. Wheat is ground into flour in a modern roller mill by passing through three processes—breaking, purifying, and reduction. The normal flour stream operates in the following manner:

(1) The wheat first passes through several sets of break rolls which crush the grain into finer particles. Any "break" flour produced at this early stage is of poor quality and is separated from the stream by sifting. It is later added to the lower grade flours. The bran separated from the endosperm by the breaking is blown out of the flour stream by air currents. The flour stream then goes to the first purifier.

(2) The purifier consists of a series of graduated sieves which vibrate as the flour stream passes over them. In the purifier the germ is sifted out, the flour is separated from the stream, and the bran is removed by air curents. The middlings (broken wheat minus germ and bran), or farina, remain in the stream to pass to the reduction rolls.

(3) The reduction rolls reduce the purified middlings to smaller particles. After passing through one series of rolls, the ground stock is sent to another purifier. Any middlings remaining after this trip through the purifier are sent to another set of reduction rolls. These processes are repeated until practically all of the endosperm is milled into flour.

6. Aging, Bleaching, and Enriching Flour

a. Aging. Freshly milled flour is not suitable for bread making. If not bleached, it must be stored for a period so that the yellowish tinge (which colors all new flour) will disappear and the proteins will undergo certain changes that are necessary before they will form satisfactory gluten. These changes which come about during storage are called aging. Under good storage conditions new flour may age sufficiently in 1 month, although it will continue to improve in baking quality for as long as 6 months. Normally, flour is ready to be used as soon as it is shipped from the miller. However, if new flour must be used, it is better to blend it with an equal quantity of flour that has been on hand for some time. If no old flour is available, good bread may be made by giving new flour doughs a rapid fermentation (par. 22a) at a slightly higher dough temperature than is ordinarily used, making a slightly stiffer dough, and using a larger quantity of yeast and salt. New flour is not to be confused with green flour, which is flour made from wheat that has not gone through the sweat. The term "sweat" refers to a natural change which takes place in the wheat kernel at some time subsequent to harvest. It involves chemical changes which benefit baking quality. Green flour may eventually make a satisfactory loaf if allowed to age.

b. BLEACHING. It is no longer necessary to store flour for months before it will make good bread. If flour is treated with one of several bleaching agents, the effects of aging are almost instantly attained. The coloring is bleached out and the flour takes on the improved baking qualities of a properly matured product. If properly bleached, flour may be milled and used the same day with excellent results.

c. ENRICHING FLOUR. During the milling of wheat the mineral and vitamin contents of the wheat are largely removed. To replace these highly important nutritive elements, small quantities of edible chemicals containing the proper proportions of thiamin (vitamin B_1), niacin, iron (Fe), and riboflavin (vitamin B_2) are added to the flour after milling. This replacing of vitamins and minerals is called enriching. Enriched flour has all the characteristics of white flour and most of the nutritive value of whole-wheat flour as well.

7. Grades of Flour

While there are many possible subdivisions in grade, the basic grades of flour are as follows:

a. PATENT. Patent flour constitutes from 40 to 90 percent of the best portion of the flour. It contains the smallest quantity of bran specks, and, when milled from hard wheat, it is capable of yielding the excellent quality of gluten desired for bread making. Patent flours are sometimes further separated into short patent and long patent—short patent being the higher grade.

b. CLEAR. Clear flour is that portion (excepting low-grade) remaining after the patent flour is separated from the flour stream. Clear flour does not make satisfactory white bread because it results in a dark crumb due to the presence of fine bran particles. However, clear flour milled from hard wheat may be blended with rye or whole-wheat flour to make either of these darker breads. Clear flours are sometimes subdivided as first (or fancy) clear flour and second clear flour. First clear flour is the better grade since it is that portion remaining after the separation of the short patent flour. Second clear flour is the portion remaining after the separation of a long patent flour.

c. LOW-GRADE. Low-grade flour (sometimes called red dog) consists of from 3 to 5 percent of the total flour and is obtained at the first and last stages of milling. It is dark, containing considerable bran specks and dirt. Generally it is used for sizing, paste, or feed, but not for bakery products.

d. STRAIGHT. Straight flour is the total run of flour, including both the patent and the clear flour. Although not as high in quality as patent flour, straight flour can be made into attractive, palatable, and highly nutritive bread. When part of the patent flour is removed from straight flour, the remainder is known as cut straight flour. When an additional clear flour from another run is added, the resulting flour is known as stuffed straight.

e. WHOLE WHEAT. When there is no separation and the bran, germ, and endosperm are all milled into the finished product, whole-wheat flour is produced. Although highly nutritive, the flour results in a dark compact loaf. Whole-wheat flour blended with clear flour is usually used in the production of graham or whole-wheat bread. When stored too long, whole-wheat flour becomes rancid because of the oils in the germ.

8. Army Flour

a. The Army baker ordinarily uses "flour, wheat, type I." This is the flour purchased for bakery use in the United States and for shipment to overseas baking units. It is a bleached straight flour milled from hard spring or hard winter wheat. The flour is enriched with thiamin (vitamin B_1), niacin, iron (Fe), riboflavin (vitamin B_2), and calcium (if specified in the invitation for bids). In the zone of the interior the flour is issued in 100-pound sacks, while that intended for theaters of operations is packed in 50-pound sacks which are overpacked with five-ply double laminated bags.

b. In certain theaters of operations flour may be secured from local sources. This flour may not meet the specifications of Army flour (flour, wheat, type I). If this local flour is used, the baker must use all his skill to produce the best quality of bread possible with these ingredients.

9. Physical Properties of Flour

a. Strength. Strength in flour refers to the quality of the gluten formed by that flour. If the gluten formed is tough, resilient, and durable, the flour is said to be a strong flour. In general, strong flour will produce a high yield of large, well-developed loaves, while a weak flour will make a small loaf. Strong flours from hard wheat are desirable for bread baking; weak flours from soft wheat are better for baking cakes, pies, crackers, and similar products.

b. Absorption. Absorption is the power of flour to combine with water to form dough. Percentage of absorption is a measure of the number of pounds of water which are absorbed by 100 pounds of flour to produce a dough of the proper consistency. The percentage of absorption varies with the type and character of the wheat from which the flour was milled and the conditions under which the flour was stored. The number of pounds of water in a given bread formula varies with the percentage of absorption of the flour. The exact percentage of absorption of a flour can be determined by the absorption test discussed in paragraph 11b.

c. Color. The color of flour depends upon the kind of wheat from which it is milled, the degree of refinement, and the bleaching process. The natural color of hard-wheat flours is creamy yellow, while soft-wheat flours are usually chalky white. Impurities, dirt, or bran specks in flour result in a grayish color or a speckled appearance.

d. Odor. Odor of flour should be sweet and similar to that of freshly ground wheat. Flour that has a musty, garlicky, or other objectionable odor will not make a well-flavored bread.

e. Granulation. Hard-wheat flour has a gritty feel when rubbed between the fingers. When pressed in the hollow of the hand, it will fall apart upon being released because of the definite form of the flour particles. Soft-wheat flour has a soft slippery feel when rubbed. When compressed in the hand, it tends to pack into a rather firm lump.

10. Chemical Properties of Flour

a. Moisture Content. Flour usually contains from 9 to 15 percent water. For Army flour the maximum is 13.5 percent when milled. It absorbs or loses moisture in storage, depending on the prevailing atmospheric conditions. Excessive moisture content may cause souring and mustiness and promote the growth of mold.

b. Proteins. (1) There are five distinct proteins in flour. These fall into two groups as follows:

(*a*) The gluten proteins.
1. Gliadin.
2. Glutenin.

(*b*) The nongluten proteins.
1. Leucosin—an albumen.
2. Edestin—a globulin.
3. Protease.

(2) The two principal proteins are gliadin and glutenin, which, when mixed with water, combine to form gluten. Gluten absorbs and retains water and forms the walls of the cell structure of the dough permitting the retention of carbon dioxide. Thus the dough is caused to rise and the loaf is given volume.

c. Carbohydrates. Since there is practically no sugar in flour, starch is the principal carbohydrate, composing from 70 to 75 percent of the total mass. The starch granules absorb water during the fermentation period and the early part of the baking period. This tends to give bulk to the dough mass. Another function of the starch is to supply food for the yeast plants. Enzymes in both the flour and yeast reduce some of the starch to simple sugars which can be used for food by the yeast.

d. Fat. Fat is relatively unimportant in flour. The fat content of white flour is normally about 1.5 percent because the major portion of the fat of the wheat grain is removed in milling when the germ of the grain is removed.

e. Mineral matter. Mineral matter (commonly called ash in flour analysis) consists mainly of the phosphates of lime, magnesium, and potassium. The content is very small, running from about 0.4 percent in an average patent flour to about 0.48 percent in a straight flour (on a 13.5 percent moisture basis). Enriching adds to the ash content of flour. Army flour may have as much as 0.50 percent ash after enriching (on a 13.5 percent moisture basis).

f. Enzymes. There are two principal enzymes in flour—diastase and protease. (See par. 21.)

(1) Diastase liquefies starch, converting it into simple sugar. Some diastatic strength is necessary to provide simple sugar for the yeast used in bread making, but high diastatic strength is not desirable because the dough becomes slack and sticky during the proofing period as a result of liquefying action of the enzyme. The diastatic strength of flour is usually controlled by blending of wheats before mill-

ing or by treatment of flour during milling. (See par. 47 for further discussion of diastatic strength.)

(2) Protease softens gluten and makes it elastic. Normally, hard-wheat flours have adequate protease for bread making.

g. Acidity. For best results in bread making, flour (and later dough) should be slightly acid. The intensity or degree of acidity in flour or dough is known as the hydrogen ion concentration. This degree of acidity is expressed by the term $_pH$. Ranges of $_p$H run from extremely acid to extremely alkaline. Extreme acid activity is expressed by 1; a $_pH$ of 7 means a neutral substance, neither acid nor alkaline, such as distilled water; and a $_p$H of 14 means the height of alkalinity. An ordinary bread dough before fermentation has a $_pH$ of about 6; but as fermentation progresses, the action of the enzymes causes an increase in acidity to a $_pH$ of about 5.2. At this hydrogen ion concentration dough matures well, rope and mold do not readily grow (par. 110), and the taste of the bread is not affected adversely.

11. Testing of Flour

A completely standardized flour is impossible. Small variations occur in the milling; and flours made from different crops of wheat may vary widely in protein content, gluten quality, diastatic activity, and in other respects. In theaters of operations, flour secured will vary in character depending upon its source. If the baker is skilled, he can test the flour in a practical way and adjust the baking procedure so as to produce good bread. The more common tests follow:

a. Color (Pekar) Test. The color test is used in evaluating the properties of a flour of unknown quality. To compare this flour with a flour of known quality place a small quantity of each on a glass or porcelain plate and press with a spatula or table knife to form a firm, smooth mass about 2 inches square varying from about ½ inch thick at the back of the plate to a thin film at the front of the plate. A dark grayish color indicates a poorer grade of flour or the presence of dirt. Bran specks indicates a lower grade of flour. A dead chalky white indicate a soft-wheat flour or a flour that has been excessively bleached. After the color comparison has been made on the dry samples, dip the plate obliquely in a vessel of clean water, remove, and allow to dry partially. Variations in color and the presence of bran specks become more clearly visible when the samples have been so treated.

b. Absorption Test. (1) Bread formulas generally express the amounts of water as "variable." To determine the exact percentage of water to be used in a formula, the percentage of absorption of the flour to be used must be known. The absorption test will determine the percentage of water the flour will absorb in producing a dough mass of the consistency desired. This test should be made before a new shipment of flour is used in a bread dough.

(2) The following procedure is used to determine the percentage of absorption of a flour: Take a carefully weighed sample of flour, and add enough water to produce a dough mass of the consistency desired. Mix the dough carefully so that all of the flour is incorporated into the dough. Then weigh the mixture and subtract the weight of the flour in order to find the weight of the water. Using the weights obtained, apply this formula:

$$\frac{\textit{Weight of water}}{\text{Weight of flour}} = \text{Percent absorption}$$

Example

Weight of dough	16 oz.
Minus weight of flour	10 oz.
Gives weight of water	6 oz.

Therefore, percentage of absorption equals 6 divided by 10 or 60 percent.

c. Gluten Tests. Before using an unknown flour in a dough compare the gluten with that of a known flour. If the quality of gluten differs from that of the flour previously used, change the baking procedure somewhat in order to assure bread of high quality. To test the gluten, take carefully weighed samples (100 grams is often used where laboratory scales are available) of the known flour and the flour to be tested and place each in a cup or other vessel. Add water to each and mix until dough of the desired consistency is attained. Then allow both samples of dough to stand immersed in cold water for half an hour to allow the gluten to form and mature. Then knead each sample under a thin stream of water to wash out all of the starch particles. Squeeze the ball over a glass of clear water to see if all the starch has been removed. If the water clouds, continue the kneading and washing; if the water is clear, let the gluten ball remain in the water for another half hour. The gluten will then be ready for testing.

(1) *Color of gluten.* To make the color test, place the ball of gluten in the palm of one hand. With the thumb of the other hand press the ball through a small opening made between the thumb and forefinger. A glistening pearl gray color indicates hard patent flour. A dull darker gray color indicates hard straight or clear flour. A light or whitish color indicates soft flour. A yellow color indicates a lightly bleached or unbleached flour. By comparing the color of the gluten of the known

flour with that of the unknown flour, the baker has a better idea of the probable baking qualities of the new flour.

(2) *Tensility of gluten.* To test for tensility or elastic properties, grasp the gluten ball between the thumb and fingers of each hand and stretch it in all directions to make a square as large as possible. Gluten from a strong, hard flour will stretch in all directions until it is almost transparent without breaking or showing tear holes. A weaker gluten will not stretch as far as hard-flour gluten and will tear more easily. The gluten from soft flour will readily tear and often completely separate.

(3) *Weight of gluten.* The percentage of gluten in flour may be determined by the weight test. Since experiments have shown that wet gluten weighs about 3 times as much as dry gluten, weigh each sample and divide by 3 to determine, for all practical purposes, the weight of the dry gluten. Then divide the computed weight of dry gluten by the weight of the flour sample used to determine the amount of gluten in the flour.

Example:

Weight of flour used....................	100 grams
Weight of wet gluten....................	33 grams
Weight of dry gluten....................	11 grams

Percent gluten in flour 11 ÷ 100 or 11 percent

d. BAKING TESTS. The conclusive test of any flour is the kind of bread that can be made from it. Baking tests may be used to determine the quality of an unknown flour in comparison with known flours, and to establish the exact formula and procedure to be used to get the best bread possible from the flour at hand. Test doughs may be regular production "test runs," small quantity doughs (enough to make 3 to 5 loaves), or they may be laboratory doughs if facilities are available. The following tests are generally used. Others may be added if the situation requires:

(1) *Standard bake.* Using the standard formula, make one dough from the flour being tested and one from the known flour. Bake loaves from both these doughs and compare. (See par. 95.) Be careful to use exact weights for the ingredients and process the doughs in the same manner, using the same procedure and identical times and temperatures for all operations.

(2) *Fermentation test.* In order to determine the proper fermentation time for the unknown flour, make two additional doughs using the test flour and following the same procedure as above except to vary the fermentation time. Give one dough 30 or 45 minutes less fermentation time than normal and the other 30 or 45 minutes more fermentation. By comparing the loaves the best fermentation time for the test flour can be determined.

(3) *Other baking tests.* If the quality of bread is not satisfactory, other baking tests may be carried out, such as tests to determine the proper percentage of salt, yeast, or sugar to be used. In each case, all factors such as ingredients, measurements, procedure, times, and temperatures must be carefully controlled except that the experimental factor will be varied as the test requires. If the experimental loaves are scored and the faults revealed are checked against the lists given in chapter 4, baking tests are valuable aids in helping the baker produce the best bread possible.

12. Storage of Flour

When properly stored, good flour will keep 6 months and improve in bread-making qualities during that time. Improper storage results in mold growth, insect infestation, foreign odors, and rapid deterioration. Because proper storage conditions are difficult to maintain at baking installations and because of the danger of deterioration, stocks for more than 60 days should not be kept. Regardless of the stock level of flour, however, the following conditions should be maintained when flour is stored.

a. SEGREGATION. When possible, the warehouses or tents should be used only for the storage of flour (or at least the bread ingredients). This policy eliminates the possibility of the flour absorbing odors from other items.

b. TEMPERATURE AND MOISTURE. Flour should be kept in a dry, cool place with a temperature not higher than 70° F. and a relative humidity of 65 percent. The temperature should be kept uniform if possible. Excessive heat or humid atmosphere causes rapid deterioration.

c. VENTILATION. The storage area for flour must be ventilated to prevent the flour from becoming musty. Sufficient space must be left along walls, between stacks, and overhead to allow free circulation of air around the flour.

d. STACKING. When stacking flour these rules should be followed:

(1) Sacks of flour must be stacked on skids or dunnage that will keep them at least 5 inches above the floor.

(2) Aisles must be planned so that there is plenty of space for handling the flour and for ventilation.

(3) Stacks must be arranged so that the oldest flour will always be used first.

(4) Stacks of flour must be clear of walls, columns, and floor.

(5) When tents or low buildings are used for storage, stacks must be low enough to allow adequate space between the top of the stack and the roof for proper air circulation.

(6) Sacks should be stowed on the dunnage or skids by the header-and-stretcher method. Sacks should be stacked no more than 8 courses high with an additional sack on top as shown in figure 2. This results in a maximum of 25 sacks to the stack.

Figure 2. Proper method of stacking flour. The header-and-stretcher method makes a stable stack.

e. Cleanliness and Prevention of Pest Infestation. Absolute cleanliness is essential to prevent infestation from weevils, roaches, and other insects. No refuse, empty unwashed sacks, or other material should be allowed near the flour, either under or on the racks or dunnage. Aisle areas and space under the stacks should be swept frequently. When all the flour is removed from a skid or dunnage, the skid or dunnage should be thoroughly brushed and sprayed with an approved fluid. Frequent inspection of flour stacks to discover the presence of insects is necessary. The best precaution against rats and mice in a storeroom is to eliminate all holes and large cracks in the floors and walls. If rats do get into the flour storeroom, they cut the sacks, which allows the flour to waste and creates excellent conditions for the growth of weevils. To get rid of rats, traps should be used rather than poison because the poisoned rats sometimes burrow into the flour before dying.

Section III. WATER

13. Functions of Water in Bread

a. In Bread Manufacture. Water is a basic ingredient in bread making. It has the following functions:

(1) Makes possible the formation of gluten. (See par. 10b.)

(2) Determines the consistency of dough. (See par. 9b.)

(3) Assists in the control of dough temperature. (See par. 54e.)

(4) Dissolves the dry milk, sugar, and other dry ingredients for better incorporation into the dough. (See par. 56.)

(5) Makes possible the development of yeast. (See par. 17.)

(6) Wets and swells the starch and renders it soluble. (See par. 10c.)

b. In the Finished Bread. The finished loaf should retain up to 38 percent water 1 hour after baking in order to be firm and palatable. Bread containing too much moisture is soggy and susceptible to mold growth.

14. Kinds of Water

Because water is virtually a universal solvent, all natural water contains minerals which have dissolved into it as it came in contact with the soil. Because the mineral content of water may affect the quality of the bread in which it is used, the baker should know how to utilize or counteract the minerals. (See app. IV for table showing the kinds of water, the minerals present, the effects of the minerals on bread, and the remedy.)

a. Hard Water. (1) Water that contains an appreciable amount of chemicals is hard water. If a soap lather does not form easily in water, the water is hard. The minerals usually found in hard water are calcium, magnesium, and iron. The minerals must be in carbonate or sulfate form in order to dissolve in water. When water is boiled carbonates will separate from the water and thus render it soft. Therefore, hard water containing carbonates is called temporary hard water. Since sulfates will not separate from the water when it is boiled, water containing sulfates is called permanent hard water.

(2) Slightly hard water is desirable for use in baking. The minerals strengthen the gluten; the sulfate aids in the growth of yeast. However, extremely hard water may slow the fermentation process by toughening the gluten too much. Usually this condition can be corrected by increasing the amount of yeast in the formula.

b. Soft Water. Soft water is relatively free of dissolved minerals. When it is tested with soap, lather forms freely. Very soft water, when used as a bread ingredient, has a tendency to soften the gluten and thus produce a soft sticky dough. This reduces the effectiveness of the fermentation period and results in inferior bread. To offset this, the percentage of salt used must be increased to strengthen the gluten when soft water is used.

c. Alkaline Water. Water that has dissolved alkaline minerals, such as sodium carbonate, from the soil is called alkaline water. To determine whether water has alkaline content, test it with litmus paper or with phenolphthalein. Red litmus paper placed in alkaline water will turn blue. A few drops of phenolphthalein will turn a sample of alkaline water red. If alkaline water is used as a bread ingredient, the mineral partially neutralizes the natural acidity of the dough. As a result, the gluten does not ripen normally; the activity of the enzymes is decreased so that fermentation is slowed and the dough becomes weak. To counteract the alkaline content the water, a small amount (exact quantity must be determined by test) of vinegar is added to the dough.

d. Acid Water. Occasionally water may contain sulfur compounds which make it acid. Acid water is often found near old mines and mine wastes. To test water for acidity, place blue litmus paper in a sample of the water. If the paper turns red, the water is acid. Acid water increases the dough acidity and hastens fermentation. To correct this condition, remove the acid by filtering the water.

e. Sea Water Sea water contains varying quantities of salt. In theaters of operations where the supply of fresh water is limited, sea water, when approved by the Medical Department, may be used as a bread ingredient. When sea water is used, the salt called for by the formula is left out. Otherwise the same formulas are used. Normally, the salt content of sea water runs from 2 to 3 percent, which is adequate for bread making. However, if the percentage of salt in sea water is too low to produce good bread, small amounts of salt may be added to bring the formula into balance. The exact amount must be determined by baking tests. (See par. 11.)

Section IV. YEAST

15. Definition and Characteristics of Yeast

a. Definition. Yeasts are microscopic plants which multiply by budding. Thousands of varieties of yeast plants have been identified, but most of them are undesirable for bread making.

b. Characteristics of Yeast to be Used in Bread Making. A good yeast for baking purposes must have the following characteristics:

(1) It must be dependable. In other words, it must be capable of raising and conditioning a batch of dough at the same rate and in the same manner whenever it is used.

(2) The yeast must be stable over a considerable period of time, even when exposed to room temperature for several hours.

(3) It must produce carbon dioxide at a rate that will conform to the rate at which the gluten is conditioned by the enzymes.

(4) It must not produce, during fermentation, any substance which will affect adversely the taste, color, or appearance of the bread.

(5) It must contain enzymes in the proper relative strength so that the dough will condition properly at the same rate and in the same manner each time this type of yeast is used.

(6) It should be free from molds and other contaminating organisms.

(7) It must be able to ferment various sugars found in doughs under all conditions.

(8) It should not be greatly inhibited by the salts in the dough.

c. Bakers' Yeast. Bakers' yeast consists of highly selected strains of the yeast classified as Saccharomyces cerevisiae, a fungus which has characteristics conforming to those requirements listed above. This yeast is selected because of its stability, ability to ferment various sugars, resistance to the inhibiting action of salts, and because its use results in the suitable conditioning of doughs made from all types of flours. Bakers' yeast is commonly manufactured in three forms—compressed yeast, active dry yeast, and yeast cereal mixture. These different kinds of yeast are discussed in paragraph 19.

d. Composition of Yeast. The composition of yeast varies according to the manufacturer and the age of the product. The following table gives the average composition of compressed yeast without starch:

	Percent
(1) Protein	14.0
(2) Ash	1.9
(3) Fat	1.4
(4) Fungus cellulose	2.0
(5) Carbohydrates (by difference)	10.7
(6) Moisture	70.0
(7) Enzymes	(present)
(8) Vitamins	(present)

16. Functions of Yeast in Bread Dough

Yeast performs the following functions when used as a dough ingredient:

a. It causes fermentation, which gradually converts the heavy mass of newly mixed dough into a light, porous, elastic product. This action is known as conditioning. (See par. 20.)

b. It contains enzymes which, under proper conditions, cause fermentation and oxidation of fermentable sugars. (See par. 21.)

c. It develops the flavor in the bread.

17. Conditions Affecting the Growth of Yeast

With the proper food, air, moisture, and temperature, yeast will grow and reproduce rapidly. If the baker is to understand the nature and action of yeast, he must be familiar with the following properties which affect the growth of the plant:

a. VEGETATIVE AND SPORE STAGES. Yeast may be found in either the vegetative or the spore stage. Since the vegetative stage is the growing and fermentative stage, it is necessary that yeast be in this stage before it can perform its functions in bread making. When yeast plants are exposed to unfavorable growing conditions, such as the absence of moisture, many of the cells usually die but some cells may go into a spore form. The spores are usually present in groups of four inclosed within the walls of the mother cell. This ascospore is a reproductive stage of the plant. When conditions again favor yeast growth, the spores germinate and the yeast returns to the vegetative stage. Compressed yeast is composed largely of yeast plants in the vegetative stage. Active dry yeast is a dehydrated product composed of vegetative cells which have been properly conditioned to withstand dehydration. It must be reconstituted before it can be used in bread dough. During reconstitution the cells take up water and the yeast becomes active again.

b. EFFECTS OF MINERALS ON YEAST. Certain chemicals have definite effects upon yeast growth and fermentative activity.

(1) Chlorine-liberating compounds are toxic to yeast. Certain salts slow fermentation and others accelerate it.

(2) Sulfates are necessary for yeast growth. Slightly hard water provides adequate sulfates for yeast growth in bread dough.

(3) Phosphates such as ammonium, calcium, and sodium are necessary for good yeast action.

c. TEMPERATURE. The best temperature for the uniform growth of yeast ranges from 78° to 90° F. Below 78° F. the growth of the yeast is retarded and below 50° F. growth will practically cease. Above 95° F. the yeast may be damaged and the cells will become inactive. Yeast will be killed by temperatures of approximately 140° F.

18. Manufacture of Yeast

In the manufacture of yeast, the greatest problems are to maintain the desired strain (Saccharomyces cerevisiae), to prevent the growth of "wild" yeast of other types, and to maintain uniform stability and fermentative activity in the finished product. The production of high yield is a matter of great importance because it affects the economy of yeast manufacture. In meeting the first problem the manufacturer isolates the pure strain and keeps it under strict laboratory supervision to insure purity. To grow the laboratory specimen into quantities sufficient for commercial use a "wort," or liquor, is prepared from molasses and grain, water, and selected minerals. After this mixture is sterilized to kill any wild yeast which may be present, stock yeast from the laboratory is added to the wort and allowed to grow. The culture grown in this manner serves as seed yeast for a large commercial fermenter, where the same precautions as to preparation of wort and to sterility of equipment are observed. When the action in the fermenter is completed, the yeast is separated from the wort by centrifuging and pressing. The yeast is then formed into 1-pound cakes (or further processed to make active dry yeast), wrapped, and packaged for shipment. Uniformity of the finished product is assured by skilled control of every step in the manufacturing process.

19. Kinds of Yeast

a. COMPRESSED YEAST. Compressed yeast is bakers' yeast compressed into cakes usually of 1-pound size. Compressed yeast is generally used in Army bakeries in the United States because it is fast acting, uniform, and easily prepared for use in a dough. (See par. 54.) About 2 pounds of compressed yeast are used for every 100 pounds of flour. Some variation is necessary depending upon the formula used.

(See ch. 3.) The disadvantage of this kind of yeast is that it requires refrigerated storage. When compressed yeast is frozen, it should be thawed before use by subjecting it to a temperature of 40° to 45° F. for several hours. This will permit the yeast to reabsorb the water and thus prevent it from becoming soft and mushy. After thawing, the yeast is handled as yeast which has not been frozen.

b. Active Dry Yeast. Active dry yeast (sometimes called granular dehydrated yeast) is yeast from which all but 8 percent of the water has been removed. It is marketed in either small, hard, light brown spheres about the size of mustard seed or in small rod-like pellets. Both types are vacuum-packed. Since there is very little moisture in active dry yeast, it has, when freshly made, approximately double the strength of compressed yeast; that is, it may be used generally at the ratio of 1 pound per 100 pounds of flour. This type of yeast is the standard for oversea shipment, since it does not require refrigeration for several months of storage and acts much faster than dried yeast cereal mixtures. Even though the yeast must be reconstituted for at least 45 minutes before using (54b(2)) the dough can be mixed and ready for the oven in approximately the same time as when compressed yeast is used. Finally, it has more leavening power per unit of weight and volume than compressed yeast or dried yeast cereal mixtures and saves shipping and storage space. If stored at 70° F. or below, active dry yeast will not deteriorate appreciably for 3 months. Even at 98° F. it will keep for 18 days without appreciable loss in fermentative activity. Even when partially deteriorated, the yeast may be used by lengthening the fermentation period or by making a sponge dough. (See e(1) below.)

c. Dried Yeast Cereal Mixture. A leavening agent (sometimes called "dried yeast in cake form") is prepared by mixing a large proportion of starch or corn meal with yeast, pressing into cakes, and drying the mixture at a comparatively low temperature. The cakes are wrapped in waxed paper to make 2-ounce packages. The packages are then sealed hermetically in a shipping container. The yeast in dried yeast cereal mixtures is dormant. For this reason it will keep under ordinary storage conditions for several months. In using dried yeast cereal mixture, the normal ratio is 1 pound to 100 pounds of flour, which is only one-half the amount of compressed yeast used to the same amount of flour. The disadvantages of dried yeast is its slow action during the fermentation period. Because of this, it should be used in the straight-dough method. (See par. 56a.) When used in the sponge-and-dough method, the sponge should be given from 10 to 20 hours' fermentation at 80° F. Since the development of active dry yeast, dried yeast cereal mixture in cake form is little used by the Army.

d. Stock Yeast. Where regular issue yeast is not available or when the supply is limited, stock yeast may be used in the manufacture of bread. However, the sponge-and-dough method (par. 56b) is advisable when stock yeasts are used. Although stock yeasts are not so pure nor so uniform as bakers' yeast in any of the forms described in a, b, and c above, they can be substituted to stretch out dwindling yeast supplies. Once prepared, a portion of the stock can be used to start another batch, thus allowing baking operations even though no yeast is available.

(1) *Potato-Stock Method.* (*a*) The formula given below will make 1 gallon of potato stock. To prepare sufficient quantities to carry on baking operations, multiples of the formula must be used. The ingredients to make a gallon of stock yeast are:

Potatoes	1 lb.
Flour	4 oz.
Salt	¼ oz.
Water	Enough to make 1 gal.
Compressed yeast	½ oz.
or	
Active dry yeast	¼ oz.
or	
Stock liquid yeast	1 pt.

(*b*) Once the ingredients have been assembled, the stock yeast is prepared as follows: Clean the potatoes, cut them up and boil in enough water to cover. When they are well-done, drain and mash thoroughly. Then add the flour to the mashed potatoes. Add the water used in cooking the potatoes and enough boiling water to make a gallon of thin paste not above 145° F. Allow the thoroughly mixed paste to cool to from 80° to 86° F. and add the yeast. Set aside to ripen or develop at 80° to 86° F. The stock ripens in from 12 to 14 hours but must be used before it becomes sour.

(*c*) When bread is made with potato-stock yeast, the normal bread formula is followed except that one-half water and one-half potato stock is used instead of the normal amount of ingredient water. Another satisfactory way of using the potato stock is to separate the yeast from the stock. When potato stock ripens, the mixture separates, the liquid coming to the top and the yeast settling to the bottom. The liquid is removed, the yeast is used, but the weight of the yeast is subtracted from the weight of the ingredient water. The following formula illustrates the use of this method, showing the weights of ingredients used with 100 pounds of flour:

	Percentage	Weight (pounds)
Flour	100	100
Water	60	47½*
Salt	2½	2½
Sugar	3	3
Shortening	5	5
Dry skim milk	6	6
Malt	1	1
Potato-stock yeast (less fluid)	—	12½*
Yeast (compressed)	2	—

**Note.* Water (47½ lb.) plus stock yeast (12½ lb.) equals the 60 pounds represented by the figure of 60 percent water specified in the formula.

(*d*) Doughs which are leavened by normal potato-stock yeast require longer fermentation periods than doughs in which standard yeast is used. If it is possible to increase the yeast component of the potato-stock formula to 2 to 3 ounces of compressed yeast or to 1 to 1½ ounces of active dry yeast, the potato-stock yeast produced will require only slightly lengthened periods to ferment doughs. If the baking facility is working at full capacity and sufficient yeast is available, the more powerful formula above is recommended. However, when there is a yeast shortage the weaker formula is prescribed.

(2) *Flour-stock Yeast.* If potatoes are not available, flour may be used instead of the potatoes in the potato-stock formula, 3½ pounds of flour being substituted for each pound of potatoes. However, flour-stock yeast is not as satisfactory as potato-stock yeast and should be used only if potatoes are not available. When the ingredients for flour-stock yeast are mixed, the sugar and salt are dissolved in 1 quart of warm water. This is then added to the flour to make a stiff dough. The remainder of the water is brought to a boil and added to make a thin paste. The temperature of the paste should not exceed 145° F. The yeast is then mixed in and the preparation allowed to ripen.

e. EMERGENCY LEAVENS. (1) *Emergency sponge method.* When the supply of active dry yeast is limited or has lost its strength because of improper storage, the following emergency sponge method of bread making is prescribed. This method can be used for any size dough batch on a continuous production basis.

(*a*) *Formula.*

	Percentage	Flour basis (100-lb.)	Flour basis (42-lb.)
Sponge			
Flour	50.00	50 lb.	21 lb.
Water	26.00	26 lb.	11 lb.
Active dry yeast	.15	2½ oz.	1 oz.
Sugar	.50	8 oz.	3 oz.
Salt	.25	4 oz.	1½ oz.
Dough			
Flour	50.00	50 lb.	21 lb.
Water (variable)	31.00	31 lb.	13 lb.
Sugar	2.5	2½ lb.	1 lb.
Salt	1.75	1¾ lb.	10 oz.
Shortening	2.00	2 lb.	13 oz.
Dry milk (use more when available)	2.00	2 lb.	13 oz.

(*b*) *Procedure.* Mix the sponge ingredients and allow to ferment for 12 hours at from 82° to 84° F.; then mix the fermented sponge with the dough ingredients at 84° F. Allow the dough to ferment for 1 hour. Then make up the dough for 10-pound field garrison sheets and pan proof for another hour. Bake in the usual manner.

(2) *Old-Dough Method.* (*a*) When no yeast is available, the old-dough method of emergency leavening is the most satisfactory. In this method, a portion of the dough from a previous batch is used as leaven for the new dough. Old dough should be used within 24 hours and cannot be used if it becomes sour.

(*b*) With old dough as a leaven, the normal formula is used except that 30 percent old dough (based on the total flour in the formula) is used and the water, yeast, and flour contained in the old dough must be subtracted from the percentages in the formula. The old dough is incorporated into the new dough batch as yeast, broken into small pieces and thoroughly mixed. The dough batch must be taken as soon as it shows activity and be made up without a punch because it is too weak for such punishment. To get good quality bread, the dough must be given a long pan proof. The use of the old-dough method for the 42-pound flour basis (as is used in the field mixer) is illustrated in the following example:

	Percentage	Normal (42-pound flour basis)	Old-dough leaven (42-pound flour basis)
Flour	100	42 lb	36 lb.
Water (variable)	54–56	24 lb.	20 lb.
Active dry yeast	1–2	13½ oz.	..
Old-dough leaven	...	..	12 lb.
Sugar	3	1 lb. 3 oz.	1 lb. 3 oz.
Salt	2½	11½ oz.	11½ oz.
Shortening	4	1 lb. 10 oz.	1 lb. 10 oz.
Dry skim milk	2	13 oz.	13 oz.

20. Action of Yeast

Yeast in dough causes fermentation and this causes the dough to rise by producing a gas known as carbon dioxide. The action of the yeast is caused by the enzymes which act on the various sugars in the dough causing carbon dioxide and alcohol to form. The carbon dioxide, caught by the gluten network, causes it to expand and thus gives the dough a porous structure. During the baking period the alcohol evaporates and the carbon dioxide escapes. Yeast not only causes the dough to rise, but also helps to develop the bread flavor.

21. Enzymes in Yeasts

a. CHARACTERISTICS OF ENZYMES. Enzymes are invisible chemical substances which function as catalysts; that is, they cause changes in other substances without being affected themselves. Because of this property, small amounts of enzymes can convert a large quantity of a substance from one form to another and still remain active. Another characteristic of enzymes is that a given enzyme will cause only one type of reaction. For example, one will act on malt sugar but not on any other form of sugar. Finally, all yeast enzymes are hydrolytic; that is, they can perform their function only in the presence of water.

b. ENZYMES IN YEAST. Many enzymes have been identified as being present in yeast. However, the function of only four will be discussed in connection with bread making. These four are:

(1) *Protease.* Protease is a protein-splitting enzyme. Its function is to mellow or condition the gluten.

(2) *Invertase.* Invertase converts cane or beet sugar into simple, or invert, sugar that is, dextrose and levulose, (See par. 29c.) Before sugar can be used by the yeast for fermentation in bread making, it must be in the form of simple sugar.

(3) *Maltase.* Maltase converts malt sugar into dextrose. Malt sugar in bread dough comes either from malt sirup in the dough formula or from the conversion of the starch in flour by the enzyme diastase found in flour (par. 10f) and in diastatic malt sirups. (See par. 47a.)

(4) *Zymase.* Zymase is the fermenting enzyme in yeast. It converts dextrose and invert sugar into carbon dioxide and alcohol. Thus, invertase and maltase prepare the simple sugars which are acted on by the zymase, all three enzymes being necessary for the action of raising the dough.

22. Factors Regulating Speed of Yeast Action

a. TO SPEED YEAST ACTION. Sometimes it is necessary to increase the rate of fermentation of yeast in order to shorten the fermentation time. This is done by:

(1) *Using a slack dough.* When the amount of water is slightly increased, the dough becomes slack or soft and offers less resistance to the carbon dioxide that is formed.

(2) *Decreasing the amount of salt.* The salt in a dough acts as a brake on yeast action. By reducing the amount of salt, the fermentation rate is increased.

(3) *Raising the dough temperature.* Increased temperature within suitable limits will increase the rate of growth of the yeast and the rate of fermentation. However, the dough temperature must be kept below 95° F. because higher temperature will affect the yeast. Also, dough tends to sour more quickly at temperatures above 82° F.

(4) *Increasing the amount of yeast.* Sometimes it is necessary to increase the amount of yeast to hasten the fermentation. This is undoubtedly the most satisfactory way to shorten the fermentation time if compressed yeast is used. When active dry yeast which has deteriorated is used, the method given in paragraph 19e(1) is suggested.

b. TO SLOW YEAST ACTION. On the other hand, it may be desired to slow the yeast action. This is done by:

(1) *Using a stiff dough.* When the amount of water is slightly decreased, the dough is stiffer and offers more resistance to the rising action of the yeast. This decreases the rate of fermentation.

(2) *Increasing the amount of salt.* Increased percentages of salt will retard the action of the yeast.

Amounts in excess of 3 percent will alter the bread flavor.

(3) *Lowering the dough temperature.* When the dough temperature is lowered, the yeast plants are less active and their growth and rate of fermentation decrease. However, if the dough temperature gets below 60° F., the yeast action is very slow.

(4) *Decreasing the amount of sugar.* The sugar furnishes food for the yeast. If the amount of sugar is decreased below a certain level, the yeast plants may have to depend upon the sugar produced by the breaking down of the starch by the diastase. Since this enzymatic action is comparatively slow, the fermentation rate may be decreased. If the flour has a low rate of starch conversion, a diastatic malt sirup may be used.

23. Storage of Yeast

a. Compressed Yeast. Compressed yeast should be placed in refrigerated storage. (See par. 19a.) The yeast should be kept as cool as possible and used within 24 hours after delivery.

b. Active Dry Yeast and Dry Yeast Cereal Mixture. Since these yeasts have little moisture and are packed in moistureproof containers, they may be stored in the same storage area that is used for flour or other ingredients. The coolest part of the storage area should be used since deterioration is slower at lower temperatures. When possible, storage should be at 70° F. or below.

Section V. SALT

24. Definition and Characteristics of Salt

The salt used in baking is known chemically as sodium chloride. However, much commercial salt contains small quantities of other minerals such as calcium sulfate and chloride, sodium sulfate, magnesium chloride, or iron compounds. Salt used in bread doughs should be 99½ percent pure sodium chloride because the other minerals definitely affect the fermentation of the dough. However, 1 percent of a specified drier may be present if the salt is to be used in high humidities. When it can be used, naturally free-running salt is preferred to that which has a drier added because the carbonates which are used as driers have a retarding effect on fermentation. Coarse grains resist caking better than fine grains of salt. Flake salt resists caking better than granulated salt. (See par. 28.)

25. Functions of Salt in Bread

Since salt is one of the four essential ingredients, the baker must have a thorough knowledge of its function in bread dough to enable him to use it accurately. These functions are:

a. To Bring Out Taste and Flavor. Bread made without salt tastes flat. Salt used as an ingredient stimulates the taste nerves and brings out the natural flavor of yeast-leavened bread.

b. To Regulate Fermentation. By changing the percentage of salt in the formula, the speed of fermentation can be changed. By using more salt, fermentation is slowed giving the gluten time to condition and the enzymes time to convert more starch and sugar. This results in a better crust color and better cell structure. By decreasing the amount of salt, fermentation is speeded. Not more than 5 percent of salt (preferably not more than 3 percent), based on the weight of the flour, should be used because the taste of the bread would be affected and the yeast might be destroyed.

c. To Prevent the Growth of Wild Yeast and Bacteria. Since wild yeast and bacteria generally have little resistance, osmotic action induced by the salt will retard their growth and often destroy them.

d. To Stabilize the Gluten. Salt modifies the physical properties of the gluten, increasing its ability to hold water and to expand without tearing. This conditioning effect of salt strengthens the gluten and gives better quality bread.

e. To Help in the Production of a Whiter Crumb. Salt has no direct bleaching effect on bread, but the conditioned gluten produces a finer cell structure within the loaf. The finer cell structure casts fewer shadows and allows the passage of light through the thinner cell walls making the crumb appear lighter.

26. Amount of Salt to Use

a. Factors Determining the Amount of Salt to Use. The exact amount of salt to be used depends upon the following factors:

(1) *Character of the flour.* Weak flour requires more salt than strong flour.

(2) *Character of the formula.* A rich formula containing shortening and milk requires more salt. A lean formula requires less salt.

(3) *Fermentation period required.* A longer fermentation requires more salt.

(4) *Mineral content of the water.* Soft water requires more salt than hard water.

b. General Rules on the Use of Salt. The salt in the normal formulas ranges from 2 to 2.5 percent based on the weight of the flour. The variation is governed by these general rules:

(1) More salt is used in dark bread than for white bread.

(2) Milk bread should have more salt than bread made without milk.

(3) The percentage of salt is increased in summer months and decreased in winter months to control fermentation of off-flavors because of wild yeast and bacteria. This is necessary at baking installations where temperature control or air-conditioning equipment is not available.

27. Tests for Salt

a. Solubility. Good quality salt dissolves completely and makes a clear solution. Residue or cloudiness indicates presence of impurities and foreign minerals. Salt containing a free-flowing conditioner will give a milky solution.

b. Color. Yellowish tinge indicates the presence of iron compounds.

c. Taste. Bitter taste indicates the presence of sodium sulfate, calcium chloride, or magnesium chloride as impurities.

28. Storage of Salt

a. General Rules. When properly stored, salt does not deteriorate and may be kept for long periods. The following rules for the proper storage of salt are applicable:

(1) Store in a cool, clean, dry place away from objectionable odors.

(2) Always stack salt on dunnage or skids.

(3) Do not store salt against steam pipes or other source of heat.

b. Prevention of Caking. Salt that has become damp and then dries out has a tendency to cake into hard lumps. Even though manufacturers may use free-running conditioners to prevent this, there are times when caking takes place. To prevent caking, the general rules for storage of salt must be followed. In addition, salt must be moved from areas of high humidity to areas of low humidity. This is particularly true in cold weather. If bags of cold salt are unloaded from freight cars or trucks and transferred to damp, muggy storage areas, moisture will condense on the bags. If the bags are not moisture-proof, the moisture will penetrate the salt and cause caking.

Section VI. SUGAR

29. Definition and Characteristics of Sugar

a. General. The term sugar is applied to a group of carbohydrates which have the following common characteristics.

(1) They taste sweet in varying degrees.

(2) They dissolve easily in water.

(3) Their solutions will ferment.

(4) Most of them crystallize in well-defined forms.

b. Ingredient Sugar. The sugar which is used as an ingredient for bread is the ordinary commercial sugar made from sugar cane or sugar beets. The chemical name for this sugar is sucrose. It makes no practical difference whether it is beet sugar or cane sugar, because the two have almost identical chemical characteristics and the same sweetening power. Sugar purchased by the Army for use as a bread ingredient is white and refined and must contain at least 99.5 percent sucrose. It must not contain more than .04 percent minerals or .07 percent moisture. This corresponds to good quality granulated sugar such as that sold in grocery stores all over the country.

c. Other Sugars in Bread. There are more than one hundred sugars, but six are found in bread dough and may be classified into two groups as follows:

(1) *Compound group.* (*a*) *Sucrose.* This is the ordinary sugar of commerce derived from sugar-cane or sugar beets.

(*b*) *Maltose.* This is malt sugar found in malt extract.

(*c*) *Lactose.* This is milk sugar found in the milk of mammals.

(2) *Simple group.* (*a*) *Glucose.* This is a simple sugar which includes dextrose and starch sugar.

(*b*) *Fructose.* This is fruit sugar including levulose, which is found in fruit juices and honey.

(*c*) *Invert sugar.* This is an equal mixture of dextrose and levulose. It is produced by the action of invertase, heat, and acid on cane sugars.

30. Functions of Sugar in Bread

Sugar is not an essential ingredient for bread making but, when used, performs the following functions:

a. Provides immediate food for yeast. (See par. 20.)

b. Imparts flavor to the bread.

c. Gives a golden-brown color to the crust. The residual sugar (par. 32b) in the dough caramelizes during the baking period resulting in a good crust color.

d. Improves the texture and color of the crumb.

e. Causes a softer and more tender crust and crumb, and adds to the nutritional values of the bread.

31. Action of Sugar in Bread

a. Sources and Types. Sugar in bread dough comes from four sources. The major part comes from the cane or beet sugar (sucrose), used as an ingredient. Small percentages of sugar are added in the malt (maltose) and in the milk (lactose). The fourth source is the sugar manufactured by the yeast from the starch in the dough (dextrose).

b. Enzyme Action on Sugar. Sugar in its ingredient form cannot perform its function in bread dough. The sucrose and the maltose must first be converted to simple sugar by the enzymes. The enzymes, invertase and maltase (par. 21), convert the sucrose into the simple sugars, glucose and fructose. This action begins as soon as the ingredients are mixed. The simple sugar supply food for the growth and reproduction of the yeast plants and provide raw material for the enzyme, zymase, to convert into carbon dioxide and alcohol. The lactose in the milk is not acted upon by any enzymes in yeast. It functions as residual sugar. Some of the starch in the flour is reduced to glucose, which is then used by the yeast for food. When ingredient sugar is not included in the formula, this glucose (actually dextrose, one of the glucose group of simple sugars) is the only food for the yeast. Since the chemical processes of breaking the starch down to simple sugar take some time, the fermentation period must be longer than would be necessary if sucrose were used as an ingredient.

c. Relative Sweetness of Sugar. All types of sugar do not have the same degree of sweetness. Using sucrose as a standard, with a value of 100, the relative degrees of sweetness of the sugars found in bread are as follows:

(1)	Sucrose	100
(2)	Dextrose	68
(3)	Lactose	16
(4)	Fructose	152
(5)	Maltose	32.5

32. Use of Sugar in Bread

a. Amounts. The amounts of sugar (sucrose) to be used as ingredient in bread are varied to obtain the effect desired. Percentages up to 2.5, based on the weight of the flour shorten the fermentation period by speeding the fermentation process. However, percentages higher than 2.5 percent tend to lengthen the fermentation period. This is probably due to the acid effect of the carbon dioxide produced which inhibits yeast growth. For Army bread, percentages ranging from 1 to 4 are recommended. Most formulas (ch. 3) call for 2 to 3 percent. This quantity has a double advantage. It provides ready food for the yeast and yet assures enough residual sugar to produce the desired golden-brown crust.

b. Residual Sugar. Residual sugar is that sugar remaining in bread baked from a fermented dough. To produce a good loaf of bread, the formula must be so balanced that there is adequate residual sugar to give the crust a good color. Since lactose is not affected by enzymatic action, it will be residual sugar unless the dough sours. The amount of residual sugar in a loaf is governed by the amount of sugar added to the dough, the amount of sugar produced by enzymatic action, and the amount consumed by the yeast.

c. Liquid Sugar Products. The use of molasses sirup, brown sugar, honey, or other liquid sugar products is sometimes desirable to make dark products (rye or wholewheat bread) or to give variety to the flavor of the bread. Occasionally ingredient sugar may not be available, whereupon liquid sugar products may be used as sugar substitutes. However, honey or sirups used in white bread cause a darkened crumb. It must also be remembered that most liquid sugar products contain from 20 to 35 percent water. To get the same amount of sugar content the sugar percentage given in the formula must be increased and the water percentage must be decreased to compensate for the water in the substitute.

33. Storage of Sugar

a. General Rules. When storing sugar the following rules should be applied:

(1) The storage area should be dry and well ventilated. Sugar readily absorbs moisture. Therefore, it must be protected from dampness.

(2) Sugar must not be stored near oil, turpentine, paints, and similar items because it will absorb foreign odors.

(3) Sugar, when dry, is not affected by temperature below 150° nor by cold.

(4) It is essential that storage areas be clean and

as nearly insectproof as possible. This is necessary because sugar attracts flies, cockroaches, and ants.

(5) Dunnage should always be used.

b. Prevention of Caking. Sugar that has become damp or sugar that is moved from an atmosphere of high humidity to an atmosphere of low humidity will crust. If this condition is allowed to continue, the sugar will cake and become useless for bread making. When sugar has been exposed to conditions that might cause crusting, it is necessary to restack each day for several days to prevent caking. The best procedure is for two men to remove each sack of sugar from the stack, bring it to about waist height and drop it. They then pick it up, turn it over, drop it again, and place it on the new stack. This rough treatment will break up the crust and prevent further caking. Another method is to remove each sack from the stack, roll it over several times on the floor, and restack it. Care must be exercised in handling sugar which is packed in paper sacks as paper sacking will not withstand the rough treatment described above.

Section VII. SHORTENING

34. Definition

Shortening is an edible fat or oil. If the shortening is a solid at room temperature, it is called fat; if it is a liquid, it is called an oil. Edible fats and oils must not be confused with mineral oils which are not digestible.

35. Functions of Shortening in Bread

Shortening in a bread dough lubricates the gluten so that the leavening gas can expand it easily and smoothly and, in general, helps to produce an appetizing and desirable loaf of bread. In detail, shortening has the following functions in bread:

a. It makes the crust tender. A tender crust is desirable in garrison bread because it gives the loaf a more attractive appearance and a more pleasant taste.

b. It keeps the bread moist and improves its keeping quality. The shortening forms a microscopic film over the crumb which slows the drying out of the bread.

c. It renders the crumb soft and chewy.

d. It provides fuel and energy. This is the main purpose for using shortening in Army bread. Shortening is almost pure energy—yielding two and one-quarter times as much energy as sugar. When it is incorporated into the dough, the nutritional value of the bread is greatly increased since the shortening is 97 percent digestible.

e. Its proper use improves loaf volume.

f. Its use adds a brilliant sheen to the crumb.

36. Classification of Shortenings

Any shortening whether fat or oil, falls into one of four general classifications (with the exception of butter and margarine). Butter and margarine when used for baking are thought of as shortenings but, in general, are considered to be table spreads. The four general classifications of shortenings are as follows:

a. Meat-fat Shortenings. Any fat or oil produced by the rendering of the fatty tissue of animals may be classified as a meat-food shortening. Lard is an excellent example of this type of shortening. Rendering is merely the heating of the fatty issue until the fat separates from the connecting tissue. The resulting shortening may be used in that state or it may be further processed by filtering, refining, bleaching, and hydrogenation.

b. Vegetable Shortenings (oils). As the name implies, vegetable shortenings are obtained from the seeds (as cottonseed) or meat (as coconuts) of oil-bearing plants. The crude vegetable oil or fat is extracted either by pressing the seeds while they are hot or by the use of chemical solvents. The crude oil must be refined, filtered, and deodorized before it is suitable for edible purposes. Good examples of shortenings produced in this manner are cottonseed oil, corn oil, peanut oil, and soya oil. These oils may be further processed to remove the stearine (hard fat) that may be diffused in the oil so that the oils will not solidify when cooled to a temperature of 32° F. (the freezing point of water). The result is a highly refined oil of unusual clarity used principally as a salad oil.

c. Blended Shortenings. Blended shortenings (sometimes called compound shortenings) are made by blending together any edible oils and fats in such proportions that the finished product has a plastic consistency. They may be composed entirely of meat-food fats and oils, entirely of vegetable fats and oils, or of mixtures of the two. Parts of the fats or oils used in the mixture are usually hardened by hydrogenation. (See d below.) All blended shortenings must be refined, bleached, filtered, and deodorized before they are chilled and packaged.

d. Hydrogenated Shortenings. Edible oils may be chemically processed to change them from oils to solid fats. This process, known as hydrogenation, is accomplished by reacting the oil with hydrogen gas. Finely divided nickel is used as a catalyst for this reaction. The degree of hardness, or the consistency, of the finished product is controlled by the quantity of hydrogen reacted with the oil. Ordinarily the oil is hardened until it reaches the consistency of lard; however, the process may be continued until the oil reaches the hardness of stearine. When hardened to the consistency of stearine, the resulting hard fat can be used in the manufacture of blended shortenings. Hydrogenated shortenings must be refined, bleached, filtered, and deodorized before they are chilled and packaged.

37. Types of Shortening

The baker may have to use many types of shortening while working in Army baking installations. He should be familiar with the following types:

a. LARD. Lard is a meat-food fat made by rendering fatty tissue obtained from hogs. Lard may be grainy or smooth depending upon the way it is processed after it is rendered. Grainy lard is packed while hot and, as it cools, the harder fractions solidify and separate from the softer fractions, thus giving it a grainy feel and appearance. Smooth lard is chilled quickly by means of mechanical chilling machines, thus preventing the separation of the hard and soft fractions. Smooth lard has a more attractive appearance and is preferred by many bakers for use in bread and rolls.

b. BLENDED SHORTENINGS. (par. 36c.) Blended shortenings may be used interchangeably with lard.

c. HYDROGENATED SHORTENING. (par. 36d.). Hydrogenated shortening may also be used interchangeably with lard. Hydrogenated shortenings become hard and brittle at low temperatures and are difficult to incorporate into a dough. For the best results they should be used at temperatures between 70° and 80° F.

d. COOKING AND SALAD OILS. While oil it not issued for use as a bread ingredient in the United States, conditions in theaters of operations may require its use for this purpose. The quality of the bread remains the same except for a slight reduction in volume.

e. RENDERED FATS. A procedure for rendering excess edible fats has been adopted for all posts, camps, and stations. When these rendered fats are issued in lieu of commercial type shortenings, post bakeries substitute this product pound for pound for the normal shortening in the bread formula. However, the following points must be remembered:

(1) Rendered fats must be carefully strained to remove any solid matter and any impurities which might adversely affect the quality or flavor of the bread.

(2) Rendered fats are normally grainy, and care must be taken that the hard particles of the fat are soft enough to allow thorough mixing into the dough. Under extremely cold teperatures, it may be necessary to warm this type of fat slightly to insure its proper distribution in the doughs.

(3) Rendered fats must be sweet and fresh. Special care must be taken that no rancid fats are used. Taste them before using.

(4) Rendered fats must be free from moisture. The presence of a small amount of water will cause the fat to become sour.

38. Use of Shortenings in Bread

a. FATS OR OILS. For baking purposes lard type shortenings are preferred to shortenings in oil form. (See par. 37d.) Lard, blended shortenings, and hydrogenated shortenings are equally good. Fats can be measured more accurately and are more easily incorporated into the dough than oils. If oil is used, measuring must be done carefully because some of the oil coats the surface of the vessels.

b. AMOUNTS. (1) Shortening is an optional ingredient and bread may be made without it. However, the approved Army formulas (ch. 3) specify from 1 to 5 percent shortening based on the quantity of flour. Garrison bread requires 5 percent shortening in order to produce a tender crust and crumb. Field bread formulas specify very little shortening (1 percent). As a result, field bread has a tough crust that will stand the rough handling necessary in field distribution.

(2) While the proper amounts of shortening will bring about all the desirable qualities listed in paragraph 35, too much shortening (over 10 percent) will result in a small soggy loaf with a greasy texture and a greasy taste.

c. MIXING. The shortening must be evenly distributed throughout the dough. Fat is added in small pieces after the dough is lumpy. Oils are added slowly after the dough is lumpy. This must be done carefully to facilitate ease of mixing and thorough distribution of the fat throughout the dough.

39. Storage of Shortening

a. STORAGE AREA. Shortening is usually packed in tin or other nontransparent containers. If the shortening stock is to be drawn upon regularly for immediate use, the storage area should be dry, with a temperature of 50° to 70° F. If the shortening is to be stored for several months, the storage area should be dry with a temperature of 35° to 40° F.

b. RANCIDITY. Shortenings become rancid with age. Old stocks should be examined before they are used to determine by taste and smell whether or not the shortening has become rancid. Proper storage conditions and frequent turnover of stocks are the best assurances against losses of shortenings because of rancidity.

Section VIII. MILK

40. Definition

Milk, unless qualified, is the lacteal secretion of cows. It is one of the few common foods that are almost complete foods. When milk is incorporated into a bread dough, the bread becomes almost completely balanced nutritionally. Since milk adds so much to the nutritional value of the bread, it is included in all of the approved formulas for Army bread.

41. Functions of Milk in Bread

Milk as an ingredient in bread performs the following functions:

a. ADDS TO THE NUTRITIVE VALUE. Milk adds many important minerals to the bread, particularly essential calcium and phosphorous in the most efficient proportions. It also adds essential amino acids as part of the valuable milk protein. The milk proteins supplement the wheat proteins making a combination of proteins more efficient as food. Milk also contributes many important vitamins, especially riboflavin, of which it is the principal common food source.

b. IMPROVES THE FLAVOR AND TASTE.

c. IMPROVES THE KEEPING QUALITY Bread containing milk retains its freshness and appetite appeal much longer than bread which contains no milk.

d. IMPROVES CRUST COLOR, CRUST CHARACTER, AND TOASTING QUALITY. Milk sugar (lactose) is not fermented by yeast and remains as residual sugar. This sugar caramelizes to aid in giving the crust the desired golden-brown color. Milk proteins also give an appetizing sheen or bloom to the crust color. The crust of milk-containing bread is also more tender than that of nonmilk bread. For these reasons, bread containing milk makes better toast.

e. STABILIZES FERMENTATION. Milk slightly retards the rate of fermentation. At the same time the milk proteins strengthen the gluten. Together these reactions tend to prevent wild fermentation.

f. IMPROVES FERMENTATION TOLERANCE. (See par. 57.) Improved fermentation tolerance is a result of the stabilizing action of the milk. Doughs containing milk, therefore, produce satisfactory bread over a longer range than nonmilk doughs.

42. Types of Milk

Although dry skim milk* is normally supplied for bread-making purposes, milk may be available in any of the following forms:

a. LIQUID WHOLE MILK. Liquid whole milk is milk in its natural form. It may be either fresh or pasteurized. Fresh milk is milk that has had no processing other than straining, cooling, and packaging. There is no bacterial control other than sanitary handling from the cow to the package. Pasteurized milk has been treated with heat to kill most bacteria that may be present. The pasteurizing process changes the flavor of the milk very slightly and provides control over bacterial growth. Liquid whole milk, on an average, contains about 88.03 percent water and 11.97 percent milk solids, of which 3.5 percent are milk fat.

b. EVAPORATED MILK. Evaporated milk is the product resulting from the evaporation of a considerable portion of the water from milk. It contains not less than 7.8 percent milk fat nor less than 25.5 percent total milk solids. Generally, no sweetening is added. By removing the cream before the milk is processed, evaporated skim milk is produced.

c. SWEETENED CONDENSED MILK. Sweetened condensed milk is the product resulting from the evaporation of a considerable portion of the water from milk to which sugar has been added. It contains not less than 28 percent of total milk solids and not less than 8 percent of milk fat. The sugar content is approximately 40 percent. Skim milk is sometimes sweetened and condensed.

d. DRY MILK. Dry milk is manufactured by the evaporation of practically all the water from milk leaving only the milk solids. Either whole milk or skim milk may be dried.

(1) Dried whole milk is the product resulting from the removal of water from milk and contains not less than 26 percent milk fat and not more than 5 percent moisture. Unless the product is properly prepared and packaged, the fats in the whole milk become rancid on standing and the product deteri-

*Also known as nonfat dry milk solids. This latter term is commonly used by the dry milk trade. However, in Army baking installations the term "dry skim milk" is generally used.

orates rapidly. Dry whole milk is widely used as a beverage after being reconstituted with water. It is valuable as an ingredient in both adult and baby food.

(2) Dry skim milk (nonfat dry milk solids) is the product resulting from the removal of fat and water from milk. It contains lactose, milk proteins, and milk minerals in the same relative proportions found in the fresh milk from which it was made. It contains not more than 5 percent by weight of moisture. The fat content is not over 1½ percent by weight, unless otherwise indicated. Since most of the butterfat is removed before drying, dry skim milk has excellent keeping quality.

43. Use of Different Types of Milk in Bread

a. WHY USE DRY SKIM MILK? Dry skim milk is generally used as the milk ingredient in bread making for the following reasons:

(1) Good keeping qualities.

(2) Decreased bulk (as compared to fresh, evaporated, or condensed milk) resulting in simplified storage problems.

(3) All of the lactose (milk sugar), milk proteins, milk minerals, and water-soluble vitamins of milk are contained in dry skim milk. These nutrients increase the nutritive value of bread greatly.

(4) Dry skim milk greatly improves the flavor, taste, crust color and character, and texture of bread.

b. INTERCHANGEABILITY OF TYPES OF MILK. The bread formulas in chapter 3 are planned for the use of dry skim milk. If other types of milk are used in bread making, the formula must be properly adjusted. To use evaporated milk, the percentage of milk is increased four times and the quantity of water is reduced by the amount of water in that quantity of evaporated milk. If liquid milk is to be substituted, the percentage of milk is increased eight times and the quantity of water reduced by the amount of water in that quantity of liquid milk. For example, if a formula called for 60 pounds of water and 2 pounds of dry skim milk, any one of the following equivalents could be used:

(1) Two pounds of dry skim milk and 60 pounds of water.

(2) Eight pounds of evaporated milk and 54-pounds of water.

(3) Sixteen pounds of liquid milk and 46-pounds of water.

c. EFFECTS OF MILK ON BREAD DOUGH. The following points should be remembered when using milk in bread dough:

(1) Bread formulas call for from 1 to 6 percent dry milk based on the weight of the flour. Dry milk in this quantity performs the desired functions and improves the quality of the bread in proportion to the quantity of dry milk used. If a richer loaf is desired the percentage may be increased up to about 12 percent. Doughs with the larger quantities of milk usually need more fermentation than doughs with small percentages.

(2) Milk doughs usually need a little more mixing than nonmilk doughs.

(3) Dry milk absorbs water and thus stiffens the dough. Allowances have been made in the standard formulas for this absorption. However, if the percentage of dry milk is increased above that given in the formula, 1 percent of water must be added to a bread dough for each percent of dry milk added, up to about 6 percent. For each percent of dry milk added above a total of 6 percent, ½ percent of water must be added to yield a dough of proper stiffness. For example, if the formula calls for 2 percent of dry milk and it is desired to raise this to 6 percent, 4 percent additional water should be added—1 percent for each additional percent of dry milk.

44. Storage of Milk

For the proper storage of dry milk the following rules must be remembered:

a. Store in a clean dry place free from odors.

b. Dry milk absorbs moisture easily. If it is not kept dry, it will become lumpy. Keep containers tightly closed and placed on dunnage to assure complete dryness.

c. Under proper storage dry skim milk will keep for at least 6 months. Keep stocks small and replace often. When stored for long periods, dry milk gets stale and develops a rancid or tallowy flavor.

Section IX. MALT

45. Definition

A malt sirup is a concentrated product made from barley malt and other cereal grains. Bakers' malt sirup issued for use in bread making may be produced as a sirup or in dry form, diastatic or nondiastatic. (See par. 47.) The dried product is easier to scale, requires less storage space, and keeps longer than the sirup. However, the sirup is easier to manufacture and is widely used in the United States. Unless otherwise qualified, the term "malt sirup" in the following paragraphs refers to either the liquid or the dry form.

46. Functions of Malt in Bread

Malt sirup is an optional ingredient for bread. However, it is included in all formulas used in post bakeries. When used in bread dough, diastatic malt sirup performs the following functions:

c. PROVIDES IMMEDIATE FOOD AND MINERALS FOR THE YEAST. Soluble amino acids or amides in malt sirup are used as food for yeast growth. The mineral salts stimulate the growth of yeast. The malt sugar is readily converted to dextrose by the yeast enzymes and fermented. The dextrins are converted to maltose sugar.

b. ACTS AS A SWEETENING AGENT. The diastatic malt sirup is not used in sufficient amounts to sweeten the dough, but it adds to the total amount of sugar in the dough. However, the diastase in the malt converts the starch and dextrins into maltose sugar. This contributes to the total sugar in the dough and some of it may remain in the bread after baking. (See par. 32.)

c. IMPROVES CRUST COLOR. Caramelization of the residual sugar gives the crust the golden-brown color desired.

d. BRINGS OUT FLAVOR. Malt sirup is not used in sufficient quantity to give the bread a distinct malt flavor, but it supplements the yeast flavor to make the bread more palatable.

e. SUPPLEMENTS THE DIASTASE OF FLOUR WEAK IN DIASTASE. When diastatic malt sirup (par. 47a) is used, the diastase in the malt increases the diastatic action in the dough. This action is necessary when the flour lacks sufficient diastase to give proper amount of sugar for leavening and for flavoring the bread.

47. Classification of Malt

Malt sirups used in bread making are of the two following classes:

a. DIASTATIC MALT SIRUPS. If the flour used in the bread dough is low in diastatic activity (par. 10f), diastatic malt sirup may be used to correct this weakness. Diastatic malt sirup is manufactured in three classes, each of a different strength. The diastatic activity of the flour and the type of bread to be made determine which class of diastatic malt should be used. The diastatic strength of the malt is measured by a special measurement called "degrees Lintner." The three main classes of diastatic malt are:

(1) *Low diastatic (20° to 30° Lintner).* This is the strength of malt used by the Army.

(2) *Medium diastatic (35° to 65° Lintner).* This strength is sometimes used with certain flours, especially in making hearth bread.

(3) *High diastatic (more than 65° Lintner).* This strength is never used in normal Army baking.

b. NONDIASTATIC MALT. Nondiastatic malt sirup is a product in which the diastatic activity has been practically eliminated (10° Lintner or less). When the flour used has a high diastatic activity, nondiastatic malt sirup may be used. Thus the advantages of malt sirup in bread making can be gained without affecting adversely the finished product by excess diastatic activity.

48. Use of Malt Sirup in Bread

a. WHEN TO USE. Garrison formulas for Army bread (ch. 3) call for 1 percent low diastatic malt sirup based on the weight of the flour. It is rarely used in the field, largely because of the difficulty in handling and storing the ingredient. Low or medium diastatic malts are used when:

(1) Flour to be used is known to be of low diastatic value.

(2) Exceptionally high percentage of dry milk is used.

(3) Available water is unusually hard or is alkaline.

b. CAUTIONS IN THE USE OF MALT SIRUP IN BREAD. The following cautions are to be remembered in the use of malt sirup.

(1) A nondiastatic malt sirup is preferable when a flour is high in diastatic activity.

(2) If the dough is supplied with too much diastase (from the malt and from the flour), a sticky dough and a dark and gummy crumb will result.

(3) When in doubt as to the proper strength of malt sirup to use, make baking tests as described in paragraph 11.

49. Storage of Malt Sirup

a. MALT SIRUP. Malt sirup is adversely affected by heat and must be kept in dry cool storage. If stored at temperatures of more than 60° F., malt sirup will darken in color.

b. DRY MALT SIRUP. Dry malt sirup absorbs moisture very rapidly. It must be stored in airtight containers in a cool dry place. It is also affected by temperatures above 60° F. Dry malt sirup has a tendency to solidify when subjected to pressure, especially in high temperature storage. Therefore in storing dry malt sirup, care should be taken not to apply pressure to the dry product or subject it to heat.

c. INSECTS. Insects are attracted to malt sirup.

Every precaution should be taken to keep containers closed and to keep storage areas clean and free of spilled dry malt or sirup.

Section X. DOUGH CONDITIONERS

50. General

Commercial firms have introduced many dough conditioners which are advertised as capable of speeding up production, increasing volume, or improving the quality of the bread. These dough conditioners fall into two groups, yeast food and dough improvers.

51. Yeast Food

Commercial mineral yeast foods are very popular with bakers who use them to lessen fermentation time and to shorten proof periods. However, the Army does not recommend their use unless under exceptional circumstances. In extreme situations, because of unusual local conditions, quantities not to exceed 0.25 percent may be used if available.

52. Dough Improvers

Dough conditioners of the second group contain calcium acid phosphate or dextrinized starch and are commonly used with the sponge-and-dough method. Some of these improvers increase the water-absorbing powers of flour, while others claim to produce a better crust color or whiteness of crumb, or an increased volume. These improvers were found to be of no material use to the Army baker and their use is not approved.

CHAPTER 2

MANUFACTURE OF BREAD

Section I. PROCESSES

53. Introduction

a. The processes in the manufacture of bread extend from the storing and assembling of the ingredients to the cooling and storing of the finished product. The principal bread-making processes are:

(1) Scaling of ingredients.
(2) Mixing.
(3) Fermentation.
(4) Make-up.
(5) Pan proofing.
(6) Baking.
(7) Cooling and storing.

b. Dough may be prepared for baking by machine operation, by hand operation, or by a combination of the two. In this section the baking processes themselves are analyzed and explained. In the remaining two sections of this chapter, the details of machine and hand operation as they apply to baking in the garrison bakery and in the field bakery are discussed.

c. Operations involved in the production of bread must be carefully planned and executed, for once the mixing of ingredients has begun, a process is set in motion which cannot be interrupted without damage to the finished product. Dough formulas and dough schedules are consequently determined in advance and adhered to as rigidly as possible. The construction of dough formulas is discussed in chapter 3. The preparation of dough schedules is explained in TM 10–415 and in other War Department publications.

54. Preparation of Ingredients

a. Flour, Water, Salt, Shortening, Sugar. The first step in the preparation of a dough batch is the assembling and weighing of ingredients. Flour, water, salt, shortening, and sugar are carefully weighed in the amounts required by the formula being used. (See ch. 3.)

b. Yeast. Yeast is accurately weighed and prepared according to its type. The Army uses two types of yeast: compressed and active dry (granular dehydrated).

(1) *Compressed yeast.* To prepare compressed yeast for mixing into bread dough, crumble the yeast into a pail and add 1 quart of ingredient water for each pound of yeast. (See *e*(4) below.) After 5 minutes, mix the yeast and water thoroughly, using a wire whip, or the hands, if a whip is not available. Do not crumble the yeast directly into the dough in a dry condition and do not add the yeast on top of sugar, salt, or other concentrated ingredients, because these ingredients will harm the yeast unless they are well mixed throughout the dough.

(2) *Active dry yeast.* Since active dry yeast is largely dormant (par. 17), it must be reconstituted before it is added to the dough. To reconstitute active dry yeast, proceed as follows:

(*a*) Mix yeast and ingredient water in the proportion of 1 pound of yeast to 7 pounds of water. Add 3 ounces of sugar for each pound of yeast. This solution should be at 80° F.

(*b*) Before using it in the dough, allow the yeast, water, and sugar solution to ferment for 45 minutes at 80° F.

(3) *Other leavens.* In addition to these yeasts, other leavens may be used in emergencies. For the preparation of these leavens, see paragraph 19d and e.

c. Malt. If dry malt sirup is used, mix it with the other dry ingredients. If liquid malt sirup is used, add it to the yeast suspension and mix thoroughly. Do not allow the malt sirup and the yeast to remain in contact more than 5 or 10 minutes, or the malt sirup will seriously affect the yeast.

d. Milk. Thy dry skim milk used in Army bread must be reconstituted with water approximately 30 minutes before it is mixed. To reconstitute the milk, dissolve it in water in the proportion of 1 pound of milk to 3 or more pounds of water. The water used must be considered part of the ingredient water specified by the formula.

e. WATER. The temperature of the mixed dough is of great importance in the production of good bread. This temperature is established by controlling the temperature of the water used in mixing the ingredients. (See pars. 64a(2) and 71(b).) Thus in addition to providing water in the proper quantity, the baker must insure that the water is of the correct temperature. A dough temperature of 80° F. is usually preferred, with an allowable range from 78° to 84° F. to satisfy special conditions. To determine the desired water temperature, follow these steps:

(1) Multiply the desired dough temperature by 3.
$80° \times 3 = 240°$

(2) Add the temperature of the room, the temperature of the flour, and the amount of temperature rise in the dough caused by the friction of mixing. This temperature rise will vary from 10° to 30° F.; it should be determined for each mixer (or for hand mixing) when the first few batches of dough are mixed.

Temperature of room	75°
Temperature of flour	73°
Temperature rise	10°
	158°

(3) Subtract the figure obtained in step (2) from the figure obtained in step (1). The result (in this example, 82° F.) is the temperature of the water to be used in mixing dough.
$240° - 158° = 82°$

(4) If the result obtained in step (3) indicates that the temperature of the water must be over 100° F., then that part of the water which is used to suspend the yeast must be kept at a temperature of not more than 90° F. The temperature of the remainder of the water should be raised accordingly.

55. Mixing Process

a. Ingredients for Army bread are mixed in large, stationary mixers installed in garrison bakeries (par. 64a(3)), in portable mixers supplied for the quartermaster bakery company (par. 71c), and in dough troughs or insulated fermentation cans, by hand (par. 71d). Thorough mixing of dough is important for four principal reasons:

(1) To distribute the yeast cells throughout the dough.

(2) To distribute food for the yeast (sugars).

(3) To smooth the mass of ingredients and free it of lumps.

(4) To form and develop gluten.

b. Mixing induces the formation and development of gluten by bringing moisture into contact with the gluten-forming proteins in the flour. Thus, for the satisfactory development of gluten, all particles of flour must be thoroughly wet. Absorption qualities of flour vary widely (par. 9b), and for this reason the exact time required for proper mixing will differ according to the flour being used.

c. As mixing continues, all dough ingredients cohere, or stick together, and more and more gluten is formed until a complete gluten network is developed in the dough. The mixing process of pulling and folding the dough mass is continued until the gluten particles are arranged into something of a parallel pattern, which accounts for the smooth appearance of a well-mixed dough.

56. Methods of Mixing

The two common methods of mixing dough are the straight-dough method and the sponge-and-dough method.

a. STRAIGHT-DOUGH METHOD. In the straight-dough method, all dough ingredients are mixed at one time and prepared for a single fermentation period. Since it lends itself readily to mass production and requires less critical equipment, the straight-dough method is generally employed by the Army.

b. SPONGE-AND-DOUGH METHOD. (1) In the sponge-and-dough method, part of the ingredients are mixed and allowed to ferment before the remaining portions of the ingredients are added. Thus in this method there are really two mixing periods and two fermentation periods. The first dough mass mixed is called the sponge, and the final dough mass is called the sponge dough or simply the dough.

(2) To prepare the sponge, mix at least 50 percent of the water and flour, and all of the yeast and malt, at a temperature of 74° to 76° F. Allow the sponge to ferment from 4 to 12 hours, the time depending upon conditions. (See par. 57c(4).)

(3) After the sponge has fermented properly, put it back into the mixer or the dough trough and add the remaining portions of the ingredients. (See ch. 3.) Mix the whole mass thoroughly and then allow it to ferment until it is ready for make-up.

57. Fermentation

a. DEFINITION AND TYPES. Fermentation (par. 20), the chemical changes which take place when the ingredients of dough are mixed, starts immediately after yeast is put into the mixture and continues until the yeast is killed by the heat of the oven. There are three principal types of fermentation, only one of which is desirable in bread making:

(1) *Alcoholic.* In alcoholic fermentation, yeast

converts sugar into approximately equal parts of carbon dioxide and alcohol. (See par. 21b(4).) This is the type of fermentation desired in bread making.

(2) *Acetic.* In acetic fermentation, acetic bacteria convert dilute alcohol into acetic acid (vinegar). Such fermentation takes place at temperatures above 90° F., or in prolonged fermentation of dough, and results in a sour dough.

(3) *Lactic.* In lactic fermentation, lactic bacteria convert sugar into lactic acid. Such fermentation causes milk to sour and may occur in bread making. It produces undesirable effects in the flavor of the bread.

b. ACTIONS IN FERMENTATION. The fermentation process may be divided into two parts, called the primary action and the secondary action.

(1) *Primary action.* Raising the dough is the primary action of fermentation. In simple terms, this raising of the dough is caused by a chemical action which creates carbon dioxide gas. This gas is caught in the gluten network, and as it expands, the gluten, together with the whole dough mass, also expands.

(2) *Secondary action.* The secondary action of fermentation is the maturing or ripening of the dough as the result of changes in the combination of starch and gluten. These changes enable the dough to absorb and retain more water than it otherwise could and add to its stretching qualities. This secondary action makes the dough spongy and results in bread which is light and easily digested.

c. FERMENTATION RATIO. (1) During the fermentation period the dough is punched by hand. (See par. 58.) The fermentation ratio is the relation of the time between mixing and punching to the time between punching and the end of the fermentation period. Determination of this ratio is one of the important factors governing the quality of bread. Inasmuch as the time from mixing to punching the dough has been predetermined by test runs, a change in fermentation ratio actually means a change in the length of time from the punch until the end of the fermentation period. Great care and skill are required to determine the proper length of time required from mixing to punching the dough. (See par. 58b.) The length of the after-punch period can be varied experimentally in order that the most acceptable loaf of bread may be produced.

(2) The fermentation ratio is usually expressed as percentages of the total length of the fermentation period. The total fermentation time is taken as 100 percent. If 80 percent of this total time elapses before the dough is punched and only 20 percent after it is punched, the fermentation ratio is expressed as 80/20. Fermentation ratios of 80/20 or 70/30 generally give best results in the garrison bakery and in the field. These ratios should be used as a starting point in calculation of the ratio best suited to local conditions.

(3) (*a*) To convert the fermentation ratio to minutes, suppose that the total fermentation time is set at 3 hours, or 180 minutes. If the fermentation ratio is set at 80/20, the dough is punched when 80 percent of this time has elapsed, that is, after 144 minutes, or 2 hours and 24 minutes. Further fermentation for 36 minutes after punching will complete the total fermentation time of 3 hours, or 180 minutes.

(*b*) It is important in the application of the fermentation ratio to determine first the length of time elapsing between the mixing and punching of the dough. (See par. 58b.) When this time has been established, the total time of the fermentation period can be computed by use of the desired fermentation ratio. The following mathematical formula may be used in determining the time from punch to bench or divider, and the time of the total fermentation period:

Fermentation ratio to be used: 80/20
Dough ready to be punched in: 144 minutes

$$144 \text{ minutes} \times \frac{100}{80} = 180 \text{ minutes (total fermentation time)}$$

Thus the total fermentation time is 180 minutes or 3 hours, the time from mixing to punch is 144 minutes, and the time from punch to bench or divider is 36 minutes.

(4) It is important to remember that the exact time to perform the various operations in baking *can* be set by a schedule. The schedule is established only after the exact times are ascertained by actual experiments, and after adjustments are made to compensate for local conditions of atmospheric temperature and humidity, type and condition of flour, and other factors affecting fermentation. Once so established, the production schedule should be rigidly followed until such time as local conditions require an adjustment.

d. YOUNG AND OLD DOUGHS. A young dough is one which has been insufficiently fermented and conditioned. An old dough is one which has been allowed to ferment too long. Dough taken slightly young produces the best bread, but if it is too young it will be stiff and bucky and will not make up well into loaves.

(1) Too young a dough will color too rapidly and

deeply in the oven and will have only a small oven spring (the rise during the first few minutes of baking). The loaf produced from too young a dough will have small volume, and may have a dark reddish-brown crust, sharp corners, crust blisters, coarse grain, yellowish crumb, and wild breaks.

(2) An old dough will have a noticeable odor, will be weak or short, and will lack elasticity. The loaf produced from an old dough may rise in the oven and then drop. It may have some or all of the following characteristics: a pale crust, a gray or streaked crumb, weak texture, open grain, strong odor, poor flavor, poor keeping qualities, and irregular break and shred.

c. FERMENTATION TOLERANCE. Fermentation tolerance means the range of time a dough may stand after the normal fermentation period without injury to the finished product. Satisfactory fermentation tolerance is dependent largely on two factors in the composition of the dough:

(1) The dough must possess sufficient sugary agents or diastatic activity (par. 48) to create sugar in the dough batch continuously. There must be enough sugar to enable the yeast to raise the dough, to produce the proper degree of sweetness in the finished loaf, and to create the desired crust color.

(2) The gluten, without softening too much or becoming too slack, must retain its mellowness and its power to expand.

58. Punching

a. PURPOSE. During the fermentation process the dough is punched, or pressed down and turned over, by hand. The five principal objects of punching are:

(1) To equalize the temperature throughout the dough, which brings about a thorough and uniform fermentation.

(2) To expel some of the carbon dioxide gas that has been formed during the fermentation process.

(3) To strengthen and develop the gluten by relaxing it after its constant tension during the period of the expansion of the dough.

b. DETERMINATION OF TIME FOR PUNCH. The exact time for making the punch may be determined by inserting the fingers gently into the top of the dough to a depth of 1 to 2 inches and observing the dough closely when the fingers are withdrawn. When the proper fermentation stage for punching has been reached, the dough will neither collapse nor spring back, but sink slightly around the depression as illustrated in figure 3. This condition can be determined readily with a little experience. If the indentation caused by the fingers tends to spring back, the dough is not yet ready for the punch. If the surface of the dough falls rapidly, the proper time to make the punch has already passed and the dough should be punched at once.

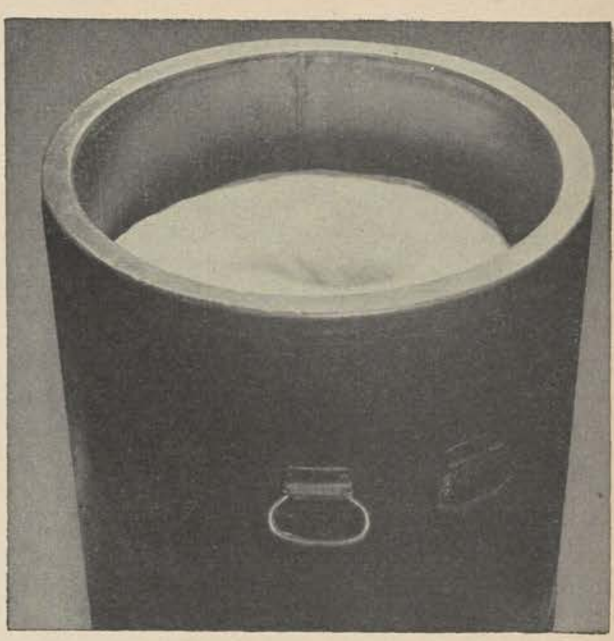


Figure 3. Dough at the proper stage for punching. Notice that when a depression is made in the dough, the dough neither falls nor springs back.

c. TIME OF PUNCH FOR DIFFERENT KINDS OF DOUGH. The time of punch varies with the percentage of yeast, malt, and sugars in the dough, the stiffness or slackness of the dough, the temperature of the mixed dough, and the temperature and humidity at which the dough is fermented. High temperature and humidity, the use of sugar, yeast food, and malt, and an abundance of strong yeast all contribute toward shortening the time necessary for bringing the dough to the proper condition for punching.

(1) *Nonyeast-food dough.* Under normal conditions a dough in which yeast food is not used will be ready to punch from 2 to 2½ hours after the time of mixing. Normal conditions include a mixed dough temperature of 78° to 84° F., and the use of 2 percent of yeast and 3 percent of sugar. The time from mixing until punching is usually from 70 to 80 percent of the total fermentation period. (See par. 57c(2).)

(2) *Yeast-food dough.* Under normal conditions ((1) above), a dough to which 0.25 percent single strength yeast food has been added will be ready to punch in 1¾ to 2¼ hours.

d. HOW TO PUNCH. When the proper time for the punch has arrived, press the dough down and fold it from the bottom to the top and from side to side until most of the gas is expelled, and the top and sides are brought into the middle. Then turn the dough over completely, so that the part of the dough that was on the bottom is brough to the top. Never punch simply by "knocking down" the dough.

c. Fermentation After Punching. After it is punched, the dough should always be allowed a further period for fermentation and recovery before it is divided. During this period the dough recovers, fermentation proceeds, the gluten continues to ripen, and the dough rises uniformly.

59. Make-up

When the dough is properly fermented, it is ready for the fourth major step in the baking process, that of make-up. The make-up period includes the time consumed in dividing and scaling, rounding, intermediate proofing, molding, and panning.

a. Dividing and Scaling. (1) First steps in make-up are dividing and scaling, that is, separating the dough mass into loaf-sized pieces and weighing the pieces to insure accuracy and uniformity.

(2) Pieces of dough lose about 12 percent of their weight in baking, chiefly through the evaporation of moisture. Thus if a 20-ounce loaf is desired, the dough must be divided into 22½-ounce pieces. Two-pound loaves are produced from pieces which are scaled at 36 ounces. The 4-pound field loaf is scaled at 72 ounces.

(3) Dividing may be accomplished either by machine (par. 66a) or by hand (par. 73a).

b. Rounding. (1) The second step in make-up is rounding each dough piece into a firm ball with a smooth, unbroken skin over its entire surface. The purpose of rounding is to produce an evenly shaped piece of dough for molding. The smooth, unbroken skin retains in the dough piece the gas generated during the intermediate proofing. This gas gives the dough piece workability either for hand or machine molding.

(2) Rounding may be accomplished either by machine (par. 66b) or by hand (par. 73b).

c. Intermediate Proofing. (1) In order to allow the dough time to recover from the effects of dividing and rounding, give it a short rest period before it is molded into loaves. If this period is not allowed, the dough is apt to be rubbery or bucky and will not mold into satisfactory loaves.

(2) The intermediate proofing period is usually 12 minutes, although this may vary from 8 to 16 minutes. (See par. 66c.) In field operations (par. 73c) this intermediate proofing may be omitted.

d. Molding. Upon completion of the intermediate proof (or rounding, if the intermediate proof is omitted), the dough pieces are molded into the shape desired for the finished loaves. Molding may be accomplished by a molding machine (par. 66d) or by hand (par. 73d).

e. Panning. After the loaves are molded they must be placed carefully, with the seam down, into properly greased pans. Too much grease will cause the loaves to burn on the bottom and too little will cause them to stick to the pan. For the methods of panning the different types of loaves, see paragraphs 66e and 73e.

60. Pan Proofing

a. Before the loaves are put into the oven for baking, they must be allowed to rest for some time under controlled conditions of temperature and humidity. This step in the baking process is called pan proofing.

b. The object of pan proofing is to enable the loaf to obtain proper volume before it goes to the oven and to give the gluten in the dough a final mellowing. Since molding compresses the dough, pan proofing is also necessary to restore lightness to the dough, which will insure proper oven spring, and to improve the grain and texture of the bread.

c. Pan proofing in a garrison bakery is generally accomplished through the use of an air-conditioned proofroom. (See par. 67.) Pan proofing in the field bakery is discussed in paragraph 74.

61. Baking

a. Dough is turned into bread when it is subjected to intense dry or moist heat in an oven. This process is called baking.

b. The oven temperature should be 450° F. when loaves are put in for baking. Loading an oven is sometimes called charging it. During the loading the temperature of the oven drops because heat escapes and the cool, damp dough absorbs heat rapidly. The oven temperature should be maintained at approximately 400° F. for the baking period. Inasmuch as all processes in the production of bread are carried out on a well-planned schedule, it is important that the ovens should be at the proper temperature when the dough is ready for baking, and during the entire baking process.

c. In order to insure uniform baking of all loaves, the pans of dough must be so spaced in the oven that the heat is evenly distributed. Pans should not touch each other; else the sides of the loaves at the points where contact is made will be underbaked.

d. Do not jar the pans as they are placed into the oven. Jarring may cause the loaves to fall and they will not have time to rise again before the yeast is killed.

e. During the first few minutes of the baking process, carbon dioxide gas within the dough expands greatly, causing a very rapid rise in the dough, known as oven spring. Fermentation is more vigorous and more rapid than at any previous stage in the bread-making process. When the inside temperature of the loaf reaches 140° F., the yeast is killed and fermentation ceases. The alcohol produced by the action of the yeast on the sugars in the dough quickly evaporates and during the baking process escapes from the dough in the form of vapor.

f. After the oven spring, the dough's pliability gradually lessens. The dough becomes set and slowly changes to bread. Some of the moisture is driven off, the starch becomes gelatinized and more digestible, and the gluten and other proteins become coagulated.

g. After the loaf is set, the intense heat dries out the part exposed to the air and causes a crust to form. Coloring of the crust should start from 10 to 20 minutes after the loaf is placed in the oven. The golden-brown color of the crust is the result of chemical changes in the starch and sugar, known as caramelization. Intensity of the color depends upon oven heat and the amount of unfermented sugar in the dough. Insufficient heat and sugar cause a pale, rubbery crust. Excessive heat and sugar cause a dark, thick crust.

h. Within the loaf, the crumb near the crust is subjected to a temperature as high as 300° F. The temperature gradually decreases toward the center of the loaf, where it never rises above 212° F. At this temperature the gluten becomes stiff enough to give the loaf permanent form and to retain its cellular structure.

i. For baking in the garrison bakery, see paragraph 68. For baking in the field, see paragraph 75.

62. Cooling

a. When the baked bread is taken from the oven, the outside of the crust is at a temperature of approximately 350° F. and the interior of the loaf is at about 210° F. The outside cools rapidly, but the inside can be cooled only by slow loss of heat through the outer crust.

b. Vapor given off from the loaf in the early stages of cooling carries with it a considerable amount of heat. Thus the loaf cools rapidly at first. When the interior of the loaf cools sufficiently, outside atmosphere is drawn into the bread. Since at this stage the bread may readily absorb any foreign odor in the surrounding air, it is highly important that the air in which it is cooled shall be free of objectionable odors.

c. It is during the cooling process that bread is also highly susceptible to mold (par. 112) and other organisms. Eternal vigilance against such contamination is the best preventive measure. Bread removed from bake pans should be handled only with clean cloths. It should be loaded carefully on racks or shelves and kept in a clean room for cooling. Loaves must not be packed tightly on the shelves but spaced so that the free circulation of air will aid in cooling.

d. Bread should cool from 2½ to 6 hours, depending on the temperature and other conditions. In extremely dry climates, the cooling racks should be covered loosely with clean cloth covers in order to prevent the excessive loss of moisture.

e. Cooling of garrison bread is discussed in paragraph 69. Cooling of field bread is discussed in paragraph 76.

63. Storing

a. Under ideal conditions, bread should be issued 5 to 24 hours after baking. Garrison bread should be consumed if possible within 36 to 48 hours after baking. Field breads (par. 77) will keep well for longer periods of time.

b. Bread should always be handled carefully, for, if the tender crust is broken, the loaf will dry out quickly. It should not be thrown into containers, but packed carefully to avoid crushing and mutilation.

c. Not more than 24 hours' supply of bread should be kept on hand, for stale bread is not acceptable to the troops. Each organization producing bread must consequently operate the bakery on a production schedule which will provide for an extra issue of bread in emergencies without the necessity of storing a large supply.

Section II. PROCEDURE IN GARRISON BAKERY

64. Mixing in Garrison Bakery

a. General. In a garrison bakery mechanical equipment is usually available for weighing and handling flour, for measuring and tempering water, and for mixing all dough ingredients. (See appropriate War Department publications for the operation and maintenance of all mechanical equipment.)

(1) A typical flour-handling unit consists of a flour dump bin, elevator, conveyor, sifter, hopper, and scale. Sacks of flour are emptied into the bin and scales are set at the proper weight of flour to be delivered to the mixer. When the machine is then put into operation, the desired amount of flour is

carried through the elevator, conveyor, and sifter, and emptied automatically into the hopper. An automatic shut-off stops the mechanism when the required amount of flour has fallen into the hopper.

(2) The quantity and the temperature of water to be placed in the mixer are generally controlled in the garrison bakery by a water-measuring and tempering device. The quantity of water to be used depends on the formula (ch. 3) and its correct temperature is determined by the method explained in paragraph 54e. The water-measuring device is set to control both the quantity and the temperature of the water, which is then delivered automatically to the mixer.

(3) Mixing in a garrison bakery is usually accomplished by large, stationary mixers. These may be designated as high speed or low speed, depending on the number of revolutions made by the mixer arms per minute. Because different speeds are desirable at different stages of mixing, mixers are also constructed so that they may operate at both high and low speed. After the ingredients are placed into the mixer, the motor is started and mechanical arms or agitators mix and knead the dough to the proper consistency.

b. Mixing a Straight Dough. (1) Prepare the yeast as directed in paragraph 54b(1) or (2).

(2) Weigh accurately all necessary ingredients.

(3) Fill the flour dump bin and see that the desired amount of flour is delivered to the hopper.

(4) Run the necessary amount of water into the mixer (tempered to secure a dough temperature of 78° to 84° F.).

(5) Put into the mixer the sugar, salt, reconstituted milk, and malt (par. 54c) and run the machine until all ingredients are dissolved.

(6) With the mixer in operation, add about one-half the flour.

(7) When a batter is formed, add the yeast suspension.

(8) Add the remaining flour.

(9) While the mixture is still lumpy, add the shortening. Do not add all in one piece. Break it into small lumps and distribute them throughout the mixture.

(10) Mix at slow speed for about 2 minutes. Finish the mixing at high speed for 8 to 10 minutes, depending principally on the characteristics of the flour.

c. Mixing a Sponge Dough. (1) Ingredients for a sponge are mixed in the same manner as those for a straight dough. (See *b* above.) The sponge should be mixed only 4 or 5 minutes at a temperature of 75° to 77° F.

(2) When the fermented sponge is ready for further mixing into dough, proceed as follows:

(*a*) Place the sponge into the mixer.

(*b*) Add the remainder of the water, tempered to get a dough temperature of 78° to 84° F. (Temperature of the sponge should be considered a factor in determining the proper temperature of the water.)

(*c*) Add all small ingredients other than shortening.

(*d*) Add about one-half the dough flour.

(*e*) Run the mixer until the sponge is thoroughly broken up.

(*f*) Add the remainder of the flour.

(*g*) While the mixture is still lumpy, add the shortening, broken into small pieces.

(*h*) Mix at slow speed for about 2 minutes. Finish mixing at high speed for 5 to 7 minutes.

65. Fermentation in Garrison Bakery

a. Most garrison bakeries are equipped with a fermentation room or cabinet in which temperature and humidity may be controlled. The room should normally be set for fermentation at a temperature of approximately 80° F. and a relative humidity of 75 percent.

b. For fermentation, dough is transferred by hand from the mixer to dough troughs. The troughs are then moved into the fermentation room or cabinet.

(1) Space in the dough troughs should be available in the proportion of approximately 2 lineal feet of space for each 100 pounds of flour mixed.

(2) To allow for expansion of the dough, only about one-third of the capacity of each trough should be used.

(3) Large dough troughs can be made to accommodate small doughs by the use of dam or spacing boards. The manner in which the dough is placed in the trough and the space it occupies are important because dough should always expand upward (vertically) rather than outward (horizontally). Too much space in the trough causes the dough to expand horizontally, and too little space causes it to overflow the top of the trough. (See fig. 4.)

c. Normal fermentation time is from 2 to 3 hours. The dough is punched once during this period. See paragraph 58 for punching of dough during fermentation.

d. See paragraph 57c(3) for the fermentation and punching of a sponge dough.

66. Make-up in Garrison Bakery

The mechanical make-up unit in a garrison bakery normally includes a divider, scales, rounder, intermediate proofer, and molder. Panning, the last step

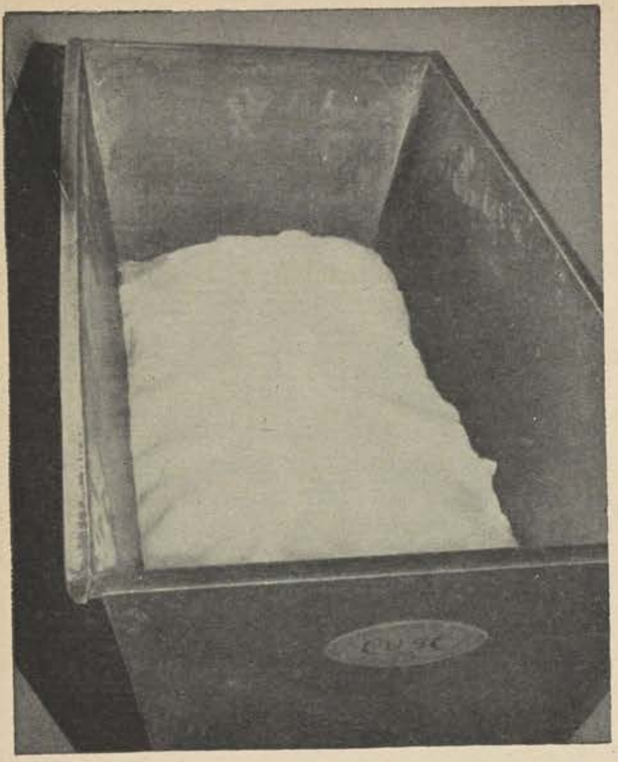


Figure 4. Dough should be spread evenly over the bottom of the trough. It should not occupy more than one-third of the total space in the trough.

in make-up, is accomplished by hand. Those machines which are equipped with variable speed controls must be set in advance to operate so that there is a continuous flow of dough from one end of the make-up unit to the other.

a. Dividing. (1) When the dough is properly fermented it is taken to the divider, a machine which measures and cuts the dough into loaf-sized pieces. Dough is transferred by hand from dough troughs to the hopper of the divider.

(2) The divider is set to cut-off whatever weight of piece is desired. If a 20-ounce loaf is being baked, the divider should cut off pieces weighing 22½ ounces. If a 2-pound loaf is desired, the divider should be set to cut off 36-ounce pieces. (See par. 59a.) A scale is provided at the divider for checking the accuracy and uniformity of its operation. As often as possible a piece of dough should be weighed on the scales and if the divider is not functioning properly, necessary corrections must be made.

b. Rounding. From the divider the pieces of dough are transferred automatically to the rounder, where they are given preliminary shape. Rounding distributes gas evenly throughout the dough pieces and forms a firm, unbroken skin over the entire surface of each piece. (See par. 59b.)

c. Intermediate Proofing. (1) In a completely mechanized make-up line, dough pieces travel automatically from the rounder to the intermediate proofer. (See par. 59c.) The proofer mechanism is adjusted so that dough pieces are conveyed through a cabinet for 8 to 16 minutes and are then delivered automatically to the molder. (See d below.) Exact proofing time is determined by dough conditions.

(2) In small bakeries the intermediate proofer may be simply a portable cabinet, into which dough pieces are placed by hand. They remain in the cabinet for the established proofing time and are then transferred, by hand, to the molder.

d. Molding. The dough pieces are next conveyed to the molder from the intermediate proofer (or are placed in it by hand). The molder may be adjusted to produce loaves of any customary size. In the molder the rounded dough pieces are at first flattened and are then curled and rolled into loaf form.

e. Panning. (1) Garrison bread is baked in individual pans (par. 59e), four or more pans being strapped together to form a set.

(2) Each loaf must be placed straight in its pan, with the seam of the loaf at the botom.

67. Proofing in Garrison Bakery

a. The garrison bakery is usually equipped with an air-conditioned proofroom, where temperature and humidity can be controlled. After the loaves are molded and panned, the filled pans are moved into the proofroom for the necessary pan proofing before baking. (See par. 60.)

b. The temperature of the proofroom should be from 90° to 95° F., for at such a temperature yeast functions most effectively. A relative humidity of 80 to 85 percent should be maintained to prevent the dough from crusting. Normal pan proofing time for garrison bread under these conditions is 50 minutes, although the necessary time may vary from 30 to 60 minutes.

68. Baking in Garrison Bakery

a. At the end of the pan proofing period the loaves are transfered quickly but carefully to the oven for baking. (See par. 61.) Undue delay or careless handling at this point will damage the finished product by softening the gluten and allowing necessary gases to escape.

b. The most desirable baking time for the 20-ounce garrison loaf is 36 minutes. The oven should be at a temperature of 450° F. for the first 10 or 15 minutes and at approximately 400° F. for the remainder of the baking period.

c. Most stationary ovens are so constructed that steam may be injected into the baking chamber.

Steam is normally used 3 to 5 minutes before the bread is loaded and is kept on until all doors are closed. The purpose of using steam is to provide moisture in the oven atmosphere. Condensation of this moisture keeps the crust of bread elastic and pliable so that it does not harden until the expansion of the dough is complete. Moisture also helps to give a smooth, attractive appearance to the loaf. Too much moisture, however, causes crust blisters and tends to make the crust rubbery.

69. Cooling in Garrison Bakery

a. For cooling (par. 62), garrison bread when it is removed from the oven should be taken from the pans and placed on clean bread racks. The loaves must be handled very carefully and should not be placed too close together. Air must be allowed to circulate freely around each loaf.

b. The loaded bread racks must be moved away from the heat of the oven room so that bread may be cooled at a temperature of 85° F. or lower. The bread racks, like the loaves themselves, must not be put too close together, because it is important to allow free circulation of air around each rack.

c. Bread should be cooled on the racks from 2½ to 6 hours.

70. Storing in Garrison Bakery

a. As a rule, garrison bread should not be stored more than 24 hours after it is baked and should be consumed within 36 to 48 hours. (See par. 63.)

b. If conditions permit, bread may remain on the cooling racks for storage until it is issued. For sanitary reasons, clean cloth covers should be placed around the racks after the bread has cooled.

c. If the racks are not used for storage, the bread may be placed on shelves in the storage room or in specially constructed bread boxes. Extreme care in sanitation and in the handling of bread must be taken at all times.

Section III. PROCEDURE IN FIELD BAKERY

71. Mixing in Field Bakery

a. GENERAL. In addition to small ingredient scales, flour scales, and the burners which furnish oven heat, a small, portable mixer is the only mechanical equipment normally available for field baking. In mixing, both the handling of flour and the tempering of water must consequently be done by hand. If the dough mixer is not available, the actual mixing of ingredients must also be done by hand.

b. ICE CALCULATION. When the desired water temperature is known (par. 54e), it is then necessary to determine the temperature of the water available for baking. Mixed dough temperature should be from 78° to 84° F. If necessary, water is then heated or cooled until it is of the proper temperature. If ice is available for cooling water, follow these steps to determine how much water and ice to use:

(1) Subtract the desired water temperature (for example, 80°) from the temperature of the water available (for example, 100°).

$100 - 80 = 20$

(2) Multiply the figure obtained in step (1) by the number of pounds of water required (for example, 25).

$20 \times 25 = 500$

(3) Divide the figure obtained in (2) by 144. (This figure (144) does not vary. It represents the number of British thermal units absorbed by 1 pound of melting ice.) The result equals the number of pounds of ice required.

$500 \div 144 = 3\frac{1}{2}$ (approx.)

(4) Subtract the quantity of ice (3½) from the desired quantity of water (25). The result is the number of pounds of water to use with the ice.

$25 - 3\frac{1}{2} = 21\frac{1}{2}$

Thus under these conditions it would be necessary to use 21½ pounds of water and 3½ pounds of ice. When the ice has melted, 25 pounds of water at the desired temperature of 80° F. would be available.

c. MIXING WITH THE FIELD DOUGH MIXER (STRAIGHT DOUGH). (1) Prepare the yeast properly. (Par. 54b.)

(2) Place salt, sugar, milk, and water into mixer bowl and run the mixer for ½ minute.

(3) Add two-thirds of the total flour and mix for ½ minute.

(4) Add the yeast suspension and mix for 1 minute.

(5) Add the remainder of the flour and mix for 1 minute.

(6) Add the shortening, broken into small lumps and softened with the hands. Mix for 2 minutes.

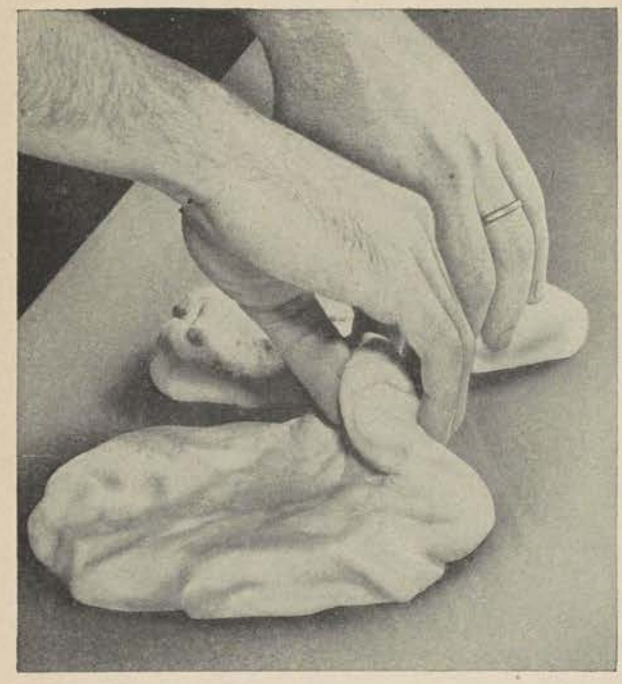
(7) Stop the mixer. Tilt the bowl and scrape down the top and sides to get all dry flour into the dough.

(8) Continue mixing until the dough is of the proper consistency. The average total mixing time will be about 15 minutes.

d. MIXING BY HAND (STRAIGHT DOUGH). (1) Prepare the yeast properly. (See par. 54b.)

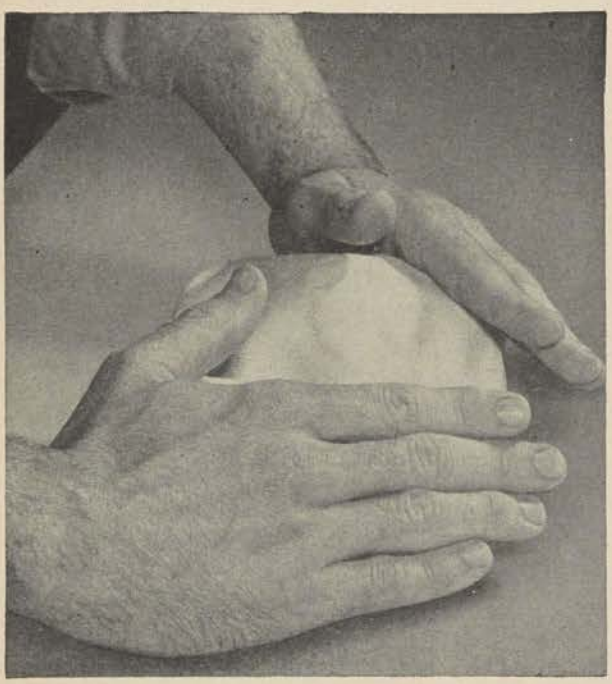
(2) Dissolve milk, sugar, and salt in a small portion of water. (Use fermentation can, bucket, or corrugated can.)

Figure 5. Steps in rounding of field garrison (sheet) bread. Proper handling of dough results in efficient operation and in well-formed loaves.



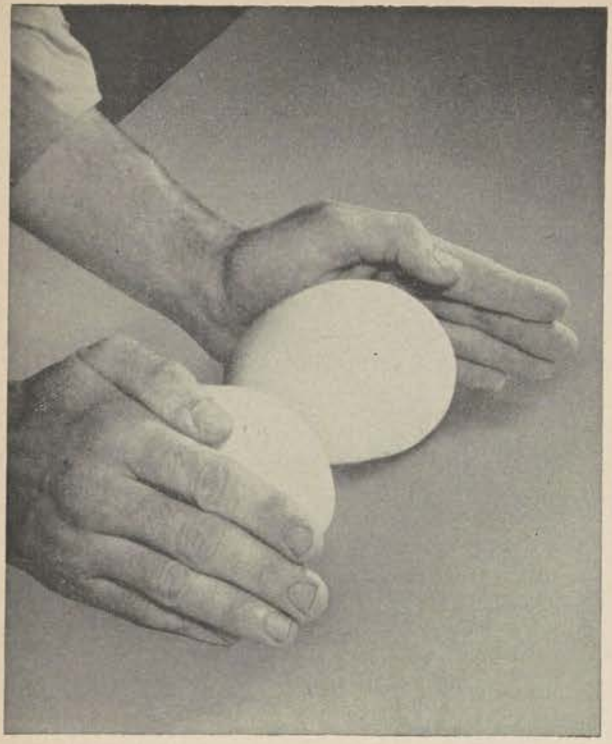
A. *Lay two dough pieces side by side. Grasp inside far corners.*

B. *Fold corners down and to sides. Place hands on dough, palms down. This folding operation seals the dough pieces.*



C. *Push dough forward and in toward center. Note new angle of hands.*

D. *Lay hands on inside far corners and fold outward, sealing a dough piece with the heel of each hand.*



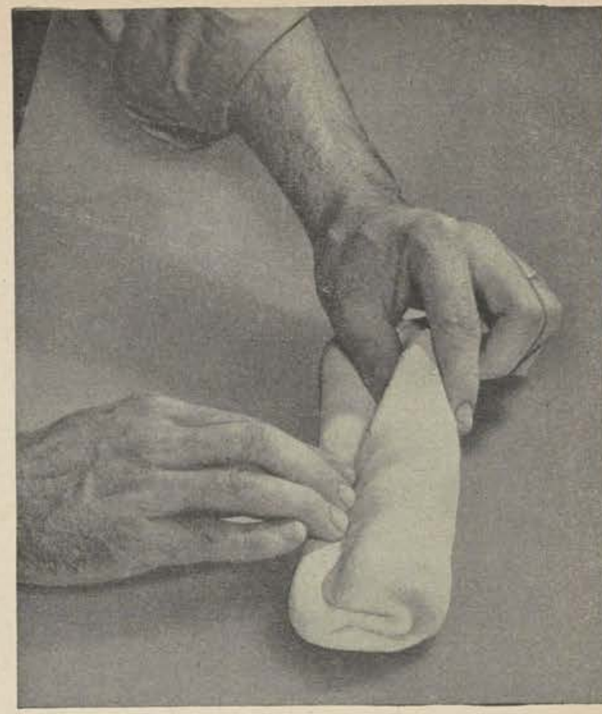
E. *Pull pieces into ball shape and round with a rolling motion, repeated several times, and put fold at bottom of each rounded piece. Result is a smooth, firm ball of dough.*

F. *First step in molding is to press the gas out of a dough piece. Then shape the dough into an oblong piece the length of a finished loaf.*

G. *Fold in the ends, making a rectangular piece.*

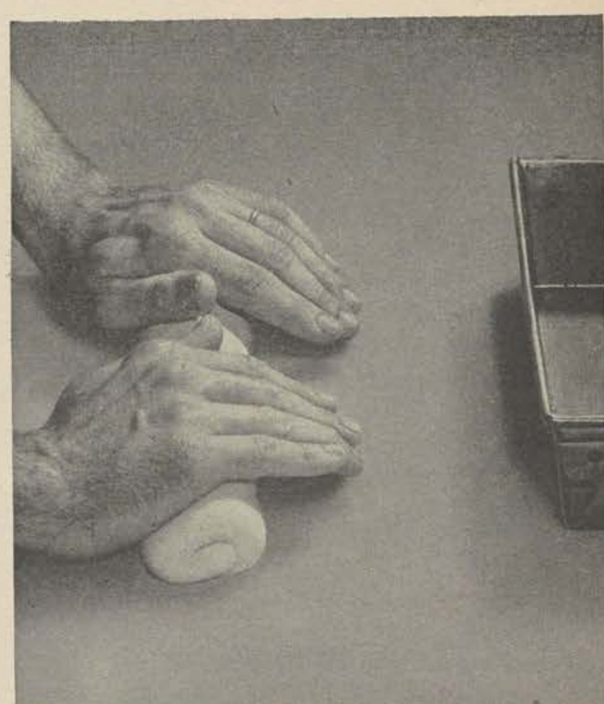
H. *Grasp far side of piece and fold it into the center. Seal with the fingers.*

I. *Fold in the lower part of the dough piece, extending it about two-thirds of the distance to the top.*



J. *Starting at the right end, lay the left thumb in the center of the piece and roll the dough into cylindrical shape. Seal the seam with the fingers of the right hand.*

K. *Repeat the rolling operation. Use left thumb to tighten the dough piece and heel of right hand to seal seam of the dough.*



L. *Roll loaf-shaped dough piece back and forth, exerting slight forward pressure with heel of each hand. This completes the molding and seals dough piece firmly.*

(3) Spread the shortening evenly over the bottom and sides of the dough trough or fermentation can which is used for mixing.

(4) If a trough is used, bank up the flour on one side. If a fermentation can is used for mixing, simply place the flour near the can.

(5) Place the remaining water in the trough or can and mix it with the dissolved milk, sugar, and salt.

(6) Mix the flour into the liquid a little at a time to make a batter. Do not use more than one-half the flour at this stage.

(7) Stir the yeast suspension into the batter.

(8) Stir the rest of the flour into the mixture, a little at a time.

(9) Continue mixing until the ingredients stick together to form one dough mass.

(10) If a fermentation can is used, remove the dough from the can and take it to the molding table. If a trough is used, roll the dough into one end or else take it to the table. With the dough scraper cut off small pieces, about 10 pounds each, and flatten them with the hands. Knead each piece separately and then remix the dough pieces until they are again formed into one mass.

(11) Repeat three or four times the mixing operation described above. Each time the dough pieces are put together, roll and fold the dough thoroughly before cutting it again. Continue kneading the dough mass until a smooth, pliable dough is obtained.

72. Fermentation in Field Bakery

When the dough is mixed, it is placed in the fermentation cans or dough troughs (fig. 4) and allowed to ferment for the necessary time (usually from 2 to 2½ hours). During this time the dough is punched once, usually on a 70/30 or 80/20 fermentation ratio. (See pars. 57 and 58.)

73. Make-up in Field Bakery

a. Dividing and Scaling. After the dough has been punched and has completed the necessary fermentation, it is transferred from the fermentation can to the table or bench. Here it is cut with a dough scraper into pieces of the proper size, which are weighed for accuracy. Field garrison (sheet) bread is scaled into 36-ounce pieces. Field bread is scaled into 72-ounce pieces.

b. Rounding. In field baking, dough pieces must be rounded by hand. For the method of rounding field garrison (sheet) bread by hand, see figure 5, (A) through (E). Field bread is rounded in a similar manner.

c. Intermediate Proofing. If field conditions permit, both sheet and field bread should be given an intermediate proof of about 15 minutes. The dough pieces are placed in pans and left on the table. They should be covered with clean cloths to keep them from crusting and to keep out the dust. If time or facilities for intermediate proofing are not available, this stage in the baking process may be omitted.

d. Molding. Both sheet bread and field bread are molded by hand. As explained in *c* above, loaves may be molded immediately after they are rounded, or a short intermediate proofing period may be allowed.

(1) *Field garrison (sheet) bread.* For the method of molding a loaf of sheet bread, see figure 5, (F) through (L).

(2) *Field bread.* To mold a loaf of field bread, flatten the rounded piece of dough until it is about 2 inches thick. Shape the dough into circular form, about 10 inches in diameter.

e. Panning. (1) *Field garrison (sheet) bread.* Sheet bread is baked in standard ration pans in 10-pound sheets made up of five 2-pound loaves. (See fig. 6.) Under certain conditions the size or number of loaves, or both, may be increased. Place each loaf in the pan carefully, making certain that the seam is at the bottom.

(2) *Field bread.* Field bread is also baked in standard ration pans, two 4-pound loaves to a pan. (See fig. 7.) To avoid damaging the crust, make certain that the loaves do not touch each other or the sides or ends of the pans. Place the seam of each loaf toward the bottom of the pan in order that the loaf may be sealed.

74. Pan Proofing in Field Bakery

a. Before loaves are placed in the oven they must be given a pan proofing period. (See par. 60.) If M-1942 ovens are used, place the pans of loaves into the proofing chambers of the oven. If this equipment is not available, an improvised proofer should be constructed. (See TM 10-415.)

b. Wash the top of the loaves lightly with water before placing them in the proofer. The water will keep the bread surface pliable, preventing the loaves from crusting during the pan proof.

c. Midway of the pan proofing period, shift the pans from top to bottom, from bottom to top, and from side to side in the proofer in order that a uniform pan proof may be obtained. When the loaves are shifted wash them again lightly with water.

d. Pan proof sheet bread for approximately 40 minutes. Pan proof field bread from 10 to 20 minutes. Proofing temperature should be from 90° to 95° F.

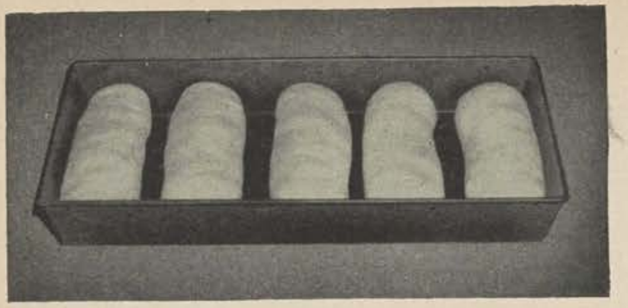


Figure 6. Panning of field garrison (sheet) bread. All loaves should lie flat in pan, with no overlapping. The loaves should be evenly spaced in the pan, with the seam of each loaf at the bottom.

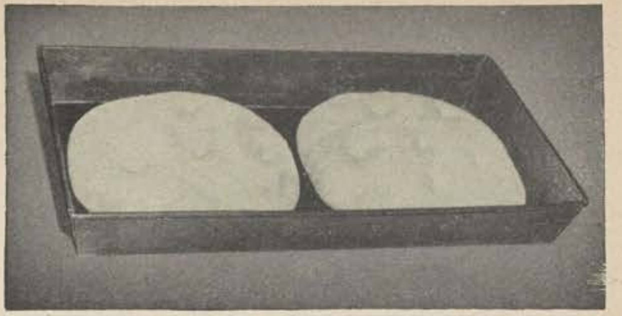


Figure 7. Field bread ready for baking. Loaves have been wet lightly and docked. Notice that edges of loaves do not touch each other or the sides and ends of the pans.

75. Baking in Field Bakery

a. FIELD GARRISON (SHEET) BREAD. When the loaves are properly pan proofed, they are placed in an oven for baking. An oven should be at approximately 450° F. when it is loaded. The temperature will drop when the bread is put into the oven and should be maintained at approximately 400° F. during the remainder of the baking period. (See TM 10-400.) Baking time for sheet bread is from 1 hour to 1 hour and 15 minutes.

b. FIELD BREAD. Before field bread is placed in the oven, loaves should be wet lightly and six or more indentations about the size of a pencil should be made in the top of each loaf. (See fig. 7.) This process, called "docking," permits steam to escape from the loaf and prevents the crust from cracking. Baking time for field bread is approximately 1 hour and 20 minutes. The oven should be at 450° F. when it is loaded.

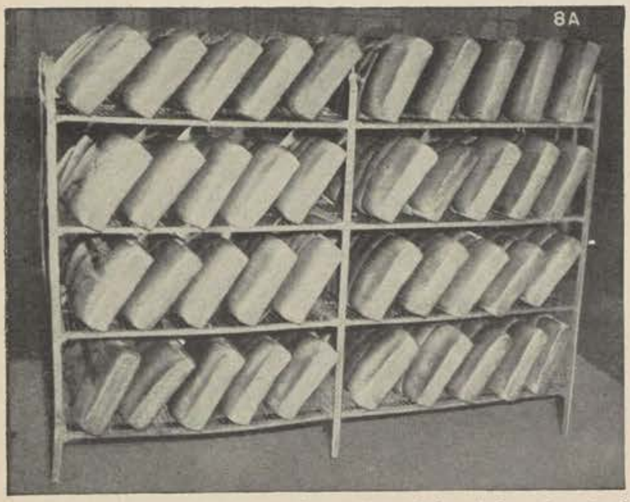
76. Cooling in Field Bakery

a. For cooling (par. 62) sheet bread should be removed from pans and stacked on its side on clean bread racks, as illustrated in figure 8A. Care should be taken not to separate the loaves until the bread is to be consumed. Lacking a side crust, the loaves will not keep well if the sheet is broken. Bread should be cooled from 2½ to 6 hours.

b. Field bread should be removed from pans and stacked on edge on clean bread racks, as illustrated in figure 8B. Since the hard, thick crust is designed to give the bread unusual keeping qualities, great care should be taken not to crack or injure the crust in any way. Field bread should also be cooled from 2½ to 6 hours.

77. Storing in Field Bakery

After it has cooled, bread baked in the field may be stored in sanitary bread boxes until it is issued. (See par. 63.) If possible, not more than 24 hours' supply of bread should be kept on hand at the field bakery, in order to insure fresh bread for troops and to avoid the danger of mold. (See ch. 5.) Sheet bread, however, will keep well for several days and well-baked field bread will remain fresh and in good condition for 2 or 3 weeks.



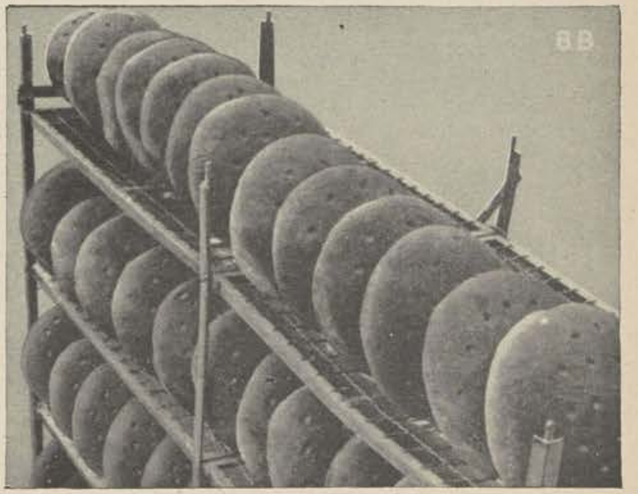


Figure 8. For cooling, field garrison (sheet) bread and field bread should be stacked carefully on edge. Loaves of sheet bread should not be separated.

CHAPTER 3

BREAD FORMULAS

Section I. CONSTRUCTION AND USE OF FORMULAS

78. Percentage Method of Formula Construction

a. In order that a formula may be used to produce any desired quantity of bread, it is expressed in terms of percentage rather than in pounds and ounces. Normally, 100 percent means the whole of anything; however, in the formula percentage used by bakers, 100 percent is always used to express only the flour content of a dough batch. The percentage of all other ingredients used is based on this figure of 100 percent for flour. For example, if 60 percent water is called for in a formula, the water content will be equal to 60 percent of the amount of the flour content. Hence, formula percentage is always more than 100 percent.

b. A standard formula, illustrating the formula percentage system, is as follows:

Ingredient	*Percent*
Flour	100
Water	60
Compressed yeast	2
Salt	2.5
Sugar	3
Shortening	5
Dry skim milk	6
Malt	1
Total percentage	179.5

79. How to Determine Weight Loss

Dough loses a certain amount of weight in the gases and moisture given off in fermentation and in baking; hence, before it is mixed according to a percentage formula, the weight loss must be known. When this is known, the weight of all ingredients can be calculated for any desired quantity of bread. Wherever possible, weight loss should be determined periodically under prevailing conditions at each bakery installation.

a. FERMENTATION LOSS. Fermentation loss is usually from 1 to 2 percent of the weight of mixed ingredients. (This includes the loss from any dough which may stick to machinery.) To determine fermentation loss under local conditions, weigh ingredients carefully for a sample dough and weigh the dough after fermentation. Subtract the second figure from the first. The result is the weight lost in fermentation. Divide this figure by the total weight of ingredients used to determine percentage of fermentation loss. For example:

500 lb.	weight of ingredients
490 lb.	weight of dough after fermentation
10 lb.	weight loss in fermentation

$10 \div 500 = .02 = 2$ percent fermentation loss.

b. BAKING LOSS. Baking loss is usually from 10 to 12 percent. This includes loss of weight in proofing and baking, plus the weight of any dough which may stick to machinery. To determine the loss under local conditions, weigh the dough after fermentation and later weigh the total amount of bread produced from that dough. Subtract the second figure from the first. The result is the weight lost in baking. Divide this figure by the total weight of the ingredients used to determine percentage of baking loss. For example:

490.00 lb.	weight of dough after fermentation
436.10 lb.	weight of bread produced
53.90 lb.	weight loss in baking

$53.90 \div 500 = .107 = 11$ percent (approx.) baking loss.

c. TOTAL LOSS IN WEIGHT AND PERCENTAGE. (1) Total weight lost in the complete baking process is found by adding the fermentation weight loss and the baking weight loss. Total percentage of weight loss is found by adding the percentage of fermentation loss and the percentage of baking loss. For example:

	Pounds	*Percent*
Fermentation loss	10.00	2
Baking loss	53.90	11
Total loss	63.90	13

(2) As a practical application of the above example, imagine that a baker were required to pro-

duce 500 pounds of bread. If the baker failed to take into account the total weight loss, and mixed only 500 pounds of ingredients, he would produce 63.9 pounds of bread less than the 500 he needed. The following paragraph explains how to take this weight loss into account when determining the weight of ingredients to use.

80. How to Determine Weight of Ingredients to Use

a. Total weight of all ingredients used is called the formula weight. This weight depends on the amount of bread required and the extent of weight loss. (See par. 79.) Since bread formulas are expressed in percentages, the simplest method is to determine first the weight of 1 percent of the total formula required. For this example, we will use the formula percentage (179.5 percent) in paragraph 78 and the amount of bread (500 pounds) and the percentage of weight loss (13 percent) from paragraph 79. One percent of the formula weight may be determined as follows:

(1) Subtract the percentage of weight loss from 100.

$100 - 13 = 87$

(2) Divide the desired amount of bread by the figure obtained in (1).

$500 \div 87 = 5.747$

(3) Multiply the figure obtained in (2) by 100.

$5.747 \times 100 = 574.7$

(4) Divide the figure obtained in (3) by the formula percentage. The result will be the weight of 1 percent of the formula, in pounds. Under the conditions used, therefore, 1 percent of the formula is 3.2 pounds. (For a table converting decimals of pounds to ounces, see app. C, pt. II.)

$574.7 \div 179.5 = 3.2$

b. When the weight of 1 percent of the formula is known, the weight of each ingredient may be calculated by multiplying the weight of 1 percent by the percentage of the ingredients called for by the formula. To illustrate with the formula in paragraph 78:

(1) Ingredient	(2) Percent	(3) Weight of 1 percent	(4) Weight of ingredient in pounds
Flour	100	3.2	320.0
Water	60	3.2	192.0
Compressed yeast	2	3.2	6.4
Salt	2.5	3.2	8.0
Sugar	3	3.2	9.6
Shortening	5	3.2	16.0
Dry skim milk	6	3.2	19.2
Malt	1	3.2	3.2
			574.4

Note. Column (2) × column (3) = column (4).

Thus to produce 500 pounds of bread, if the weight loss is 13 percent, it is necessary to mix approximately 575 pounds of ingredients. By the use of this bakers' percentage system, it is possible to determine the weight of ingredients for any desired quantity of bread to be made from any of the formulas given in paragraphs 83 through 94.

c. An alternative method of arriving at the weight of ingredients required to provide a given quantity of dough is known as the "flour factor" method. Using the same figures as before, we may arrive at the necessary weights as follows:

(1) To determine the flour factor, divide the flour percent (100) by the total formula percent (179.5).

$100 \div 179.5 = .5571$

The result, .5571, is the flour factor. (If this figure is multiplied by 100, the result (55.71) shows the percent of flour in the dough.)

(2) Multiply the amount of dough required by the flour factor.

$574.7 \times .5571 = 320$

The result (320) is the number of pounds of flour required.

(3) To determine the weight of other ingredients, multiply the weight of the flour by the percent of each ingredient called for by the formula. For example, the weight of water in pounds will be:

$320 \times .60 = 192$

81. Application of Percentage Method to Sponge-and-Dough Formulas

The bakers' percentage system of formula construction applies as well to the sponge-and-dough method of mixing (par. 56b) as it does to the straight-dough method (par. 56a). The first step, as before, is to determine the weight of 1 percent of the formula. (See par. 80a.) Assuming this to be 3.2 pounds, as before, the amount of each ingredient to be used in the sponge and in the dough can be calculated as follows:

Sponge

(1) Ingredient	(2) Percent	(3) Weight of 1 percent	(4) Weight of ingredient in pounds
Flour	60	3.2	192.0
Water	36	3.2	115.2
Compressed yeast	1.5 to 2	3.2	6.4
Malt	1	3.2	3.2
Formula weight sponge ingredients			316.8

	Dough		
Flour	40	3.2	128.0
Water (variable)	24	3.2	76.8
Salt	2.5	3.2	8.0
Sugar	3	3.2	9.6
Shortening	5	3.2	16.0
Dry skim milk	6	3.2	19.2
Formula weight, dough ingredients			257.6
Total formula weight 316.8 + 257.6 =			574.4

Note. Column (2) × column (3) = column (4).

Section II. STANDARD FORMULAS FOR ARMY BREAD

82. Use of Formulas

a. Paragraphs 83 through 94 contain the approved standard formulas for the various types of Army bread. These formulas have been established on the basis of the Army's vast experience in baking, both in garrison and in the field. As explained in paragraph 78, the formulas are given in percentages rather than in pounds and ounces. When the desired type and quantity of bread are known, the proper formula may be used to determine the amount of ingredients necessary, as explained in chapter 3, section I.

b. It should be noted that the percentage of water in each formula is qualified as variable. Variation in the amount of water is permitted because the absorption power of flour varies. How to determine the exact percentage of water to use in any formula is explained in paragraph 11b.

83. Garrison Bread (Straight-Dough Method)

a. FORMULA.

Ingredient	*Percent*
Flour	100
Water (variable)	60
Yeast (compressed)	2
Salt	2.5
Sugar	3
Shortening	5
Dry skim milk	6
Malt	1

Note. Yeast food is not considered an optional ingredient and is to be used only to meet unusual local conditions. If it is used, 0.25 percent may be added with the sugar, salt, and milk.

b. PROCEDURE. Prepare the bread in accordance with the instructions contained in sections I and II, chapter 2.

84. Garrison Bread (Sponge-and-Dough Method)

a. FORMULA.

Ingredient	*Percent*
Sponge	
Flour	60
Water	36
Yeast (compressed)	1.5 to 2
Malt	1
Dough	
Flour	40
Water (variable)	24
Salt	2.5
Sugar	3
Shortening	5
Dry skim milk	6

Note. Yeast may vary from 1.5 to 2 percent. The greater the amount of yeast used, the shorter will be the time necessary for fermentation. Yeast food is not considered an optional ingredient and is to be used only to meet unusual local conditions. If it is used, 0.25 percent may be added to the sponge ingredients.

b. PROCEDURE. Prepare the bread in accordance with the instructions contained in sections I and II, chapter 2.

85. Field Garrison (Sheet) Bread (Temperate and Frigid Climates)

a. FORMULA.

Ingredient	*Percent*
Flour	100
Water (variable)	54-56
Yeast (compressed)	2
or (active dry)	1
Salt	2.5
Sugar	3
Shortening	4
Dry skim milk	2

b. PROCEDURE. Prepare the bread in accordance with instructions contained in sections I and III, chapter 2.

86. Field Garrison (Sheet) Bread (Tropical Climates)

a. FORMULA.

Ingredient	*Percent*
Flour	100
Water (variable)	56
Yeast (compressed)	1 to 1.25
or (active dry)	0.5 to 0.625
Salt	2.5
Sugar	2
Shortening	2

b. PROCEDURE. (See secs. I and III, ch. 2.) Dough made from this formula in a tropical climate requires less than the normal time for fermentation and proofing. Keep the dough on the young side to prevent the high temperature from causing it to sour.

87. Field Garrison (Sheet) Bread (Emergency Sponge-and-Dough Method)

For the formula and procedure to be used in baking sheet bread by the emergency sponge-and-dough method, see paragraph 19e.

88. Field Bread (Temperate and Frigid Climates)

a. Formula.

Ingredient	*Percent*
Flour	100
Water (variable)	51–53
Yeast (compressed)	1.5
or (active dry)	0.75
Salt	2.5
Sugar	1.75
Shortening	1
Dry skim milk	2

b. Procedure. Prepare the bread in accordance with instructions contained in sections I and III, chapter 2.

89. Field Bread (Tropical Climates)

a. Formula.

Ingredient	*Percent*
Flour	100
Water (variable)	50
Yeast (compressed)	0.75 to 1.00
or (active dry)	0.375 to 0.5
Salt	2.25
Sugar	1.5 to 1.75
Shortening	1

b. Procedure. (See secs. I and III, ch. 2.) Dough made in accordance with this formula in a tropical climate requires less than the normal amount of time for fermentation and proofing. Keep the dough on the young side to prevent the high temperature from causing " to sour.

90. Short-time Dough (Garrison Bread)

a. Formula.

Ingredient	*Percent*
Flour	100
Water (variable)	62 to 64
Yeast (compressed)	4
Salt	2
Sugar	4
Shortening	5
Dry skim milk	6
Malt	1

b. Procedure. (See secs. I and II, ch. 2.) (1) When greatly increased quantities of yeast are used, as in this formula, the time necessary for fermentation and intermediate and pan proofing is substantially reduced. It is important to allow the bread to pan proof only a short time, because the additional yeast increases the amount of gas released during the early stages of baking. If the normal proofing period for garrison bread is allowed, the bread will rise excessively in the oven.

(2) The following changes in procedure also decrease the length of time required for fermentation and proof:

(*a*) Increasing temperature of mixed dough, but not in excess of 90° F.

(*b*) Increasing temperature of fermentation room or cabinet, but not in excess of 90° F.

(*c*) Increasing temperature of proofroom or cabinet, but not in excess of 90° F.

(*d*) Increasing percentage of yeast used, but not in excess of 5 percent.

(*e*) Increasing percentage of sugar used, but not in excess of 6 percent.

(*f*) Increasing percentage of water by 2 to 4 percent to produce a slack dough.

(*g*) Using mineral yeast food, but not in excess of 0.5 percent.

91. Short-time Dough (Field Garrison (Sheet) Bread)

a. Formula.

Ingredient	*Percent*
Flour	100
Water (variable)	56 to 58
Yeast (compressed)	2
or (active dry)	1
Salt	2.5
Sugar	3
Shortening	2
Dry skim milk	2.5

b. Procedure. (See secs. I and III, ch. 2.) Instructions contained in paragraph 90b(1) and (2) are also applicable to the production of short-time field garrison (sheet) bread.

92. Raisin Bread

a. Formula.

Ingredient	*Percent*
Flour	100
Water (variable)	65
Yeast (compressed)	4
Salt	2.5
Sugar	6
Shortening	5
Dry skim milk	4.5
Malt	1
Raisins	65

b. Procedure. (See secs. I and II, ch. 2.) More than 65 percent raisins in a dough will cause the loaves to be small, compact, and heavy. Soak the raisins in water for 30 to 35 minutes and then drain them well. Put them into the dough only for the last

2 minutes of mixing. Too long or too rapid mixing of raisins in a dough will tend to tear the raisins apart, and result in blotchy and discolored loaves.

93. Whole-Wheat Bread

a. FORMULA. (1) *Straight-dough method.*

Ingredient	*Percent*
Whole-wheat flour	50
White flour	50
Water (variable)	62
Yeast (compressed)	2
Salt	2.5
Sugar	3
Shortening	5
Dry skim milk	3
Malt	2

(2) *Sponge-and-dough method.*

Sponge

Ingredient	*Percent*
White flour	50
Water (variable)	32 to 34
Yeast (compressed)	2
Sugar	3
Malt	2

Dough

Whole-wheat flour	50
Water (variable)	30 to 32
Salt	2.5
Shortening	5
Dry skim milk	3

b. PROCEDURE. (See secs. I and II, ch. 2.) As indicated by the formulas, whole-wheat bread may be prepared by either the straight-dough method or the sponge-and-dough method. The proportion of whole-wheat flour may vary from 40 to 60 percent. More than 60 percent whole-wheat flour will tend to make the loaves darker and heavier than is usually desirable and will decrease the palatableness of the bread for the average American.

94. Rye Bread

a. FORMULA.

Ingredient	*Percent*
Rye flour (dark)	20
White flour	80
Water (variable)	58
Yeast (compressed)	3
Salt	2.5
Shortening	2.5
Malt	2.5

b. PROCEDURE. (See secs. I and II, ch. 2.) (1) *Mixing.* Blend the wheat and rye flours thoroughly. After the other ingredients are added to the flour, be careful not to mix more than 5 or 6 minutes. Overmixing of rye dough results in poor volume and in a number of large and small holes in the crumb. It also causes the sides of the loaves to burst or split because the gluten is overstretched. It is important to remember that rye flour, unlike wheat flour, should be used as soon after it is milled as possible.

(2) *Fermentation.* Since rye-flour dough contains less gluten, it should receive a shorter fermentation period than wheat-flour dough. Rye dough has a denser or heavier "feel" than wheat dough. Because of this the baker must guard against considering rye dough not fully fermented when in reality it may be completely fermented or even overfermented. Rye dough taken on the young side makes better bread than slightly old dough.

(3) *Molding.* If rye bread is to be baked in pans, mold it in the same manner as garrison bread. If the bread is to be hearth-baked, mold each loaf 10 or 11 inches long, thicker in the center than at the ends. Round the ends slightly.

(4) *Proofing.* Since rye dough requires less proofing time than wheat dough, a proofing period of 30 to 35 minutes usually is sufficient. Pan type rye bread is panned and pan proofed in the same manner as garrison bread. Facilities for the production of hearth type bread are not provided in garrison bakeries. Patent peels with detachable peel handles are necessary for this type of loaf. (Loaves of hearth type rye bread are placed on patent peels for pan proofing, the handles of the peels having been removed. To prevent sticking, place a thin layer of corn meal on the peels before the dough is put on to proof. The corn meal absorbs moisture and allows the dough to "slide" easily off the peel to the oven hearth.)

(5) *Docking.* Each loaf of rye bread should be docked in several places before it is put into the oven. Make four slashes across the top of the loaf, not more than ½-inch deep. (As an alternative, rye bread may be docked in the same manner as field bread. See par. 75b.) Docking permits the escape of carbon dioxide gas from the bread in the oven and prevents the gas from bursting the loaf at the seam or along the sides.

(6) *Baking.* (*a*) If steam is available in the oven, it should be used for rye bread for a somewhat longer period than for wheat bread. Steam insures a glossy appearance and crispy feel to the loaf and also helps to prevent wild breaks in the sides. If steam is not available, coat the loaves lightly with rye wash before they are placed in the oven and again when they are removed. Rye wash is made from water and cornstarch, in the proportion of 2 to 2½ ounces of cornstarch to 1 quart of water.

Dissolve the cornstarch in a small quantity of the water to make a soft paste. Boil the remaining water, stir it into the paste, and allow the mixture to cool.

(*b*) Pan type rye bread is baked in the same manner as garrison bread. Hearth type rye bread is baked directly on the hearth of the oven. Attach a handle to the peel on which the loaf has proofed and "slide" the loaf into the oven with a quick backward movement of the peel. To remove the baked bread, slip the peel blade carefully under the loaves and withdraw them from the oven. Peeling an oven in this manner requires considerable skill in order that loaves may not be damaged.

CHAPTER 4

BREAD FAULTS

95. Scoring Bread

a. PURPOSE. Bread scoring is done by comparing sample loaves from the bread produced with the ideal loaf of bread. In this way, minor faults are discovered and a basis for improvement of the bread is provided.

b. FACTORS IN SCORING. Scoring is done on the basis of 11 factors which contribute to the quality of bread. These are given relative weights according to their importance in the quality of the finished product. If the bread scored is perfect, it is scored 100. However, since it is practically impossible to produce perfect bread, scores will range downward from this optimum according to the quality of the bread. The factors used in scoring and their relative weights follow:

(1) *External appearance.*

(*a*) Volume	10
(*b*) Color of crust	8
(*c*) Symmetry of form	3
(*d*) Evenness of bake	3
(*e*) Character of crust	3
(*f*) Break and shred	3

(2) *Internal appearance.*

(*a*) Grain	10
(*b*) Color of crumb	10
(*c*) Texture	15
(*d*) Aroma	15
(*e*) Taste	20
Total	100

96. Volume

The volume of a loaf is its cubic volume as compared with the weight of dough used to make the loaf. The following list of faults, causes, and remedies will be helpful in correcting volume faults:

a. LACK OF VOLUME.

Possible cause	*Remedy*
(1) Use of weak flour or too strong flour.	(1) Blend flours to get the desired characteristics.
(2) Use of old, new, or green flour.	(2) Age flour properly.
(3) Use of soft, alkaline, or extremely hard water.	(3) Condition water as prescribed.
(4) Yeast improperly prepared.	(4) Prepare yeast according to directions.
(5) Incorrect scaling of ingredients.	(5) Scale ingredients carefully.
(6) Dough too hot or too cold.	(6) Keep dough within the prescribed temperature range.
(7) Overmixing or undermixing.	(7) Mix dough properly.
(8) Too much or not enough dough for mixer.	(8) Use proper size mix.
(9) Extremely old dough.	(9) Shorten fermentation time.
(10) Too much machine punishment.	(10) Use machinery properly.
(11) Pans not in proper condition.	(11) Have pans properly burned in and greased and at normal temperature.
(12) Improper atmospheric condition in proofroom.	(12) Maintain proper humidity and temperature in proofroom.
(13) Overproofing or underproofing.	(13) Determine and use the correct proofing time (both intermediate and pan).
(14) Excess or insufficient steam in oven.	(14) Use correct amount of steam.
(15) Oven too hot.	(15) Maintain proper oven temperature.

b. TOO MUCH VOLUME.

(1) Not enough salt.	(1) Use proper amount of salt.
(2) Dough slightly overaged.	(2) Ferment dough properly.
(3) Improper molding.	(3) Mold properly.
(4) Too much dough for pans.	(4) Scale dough properly.
(5) Overproofing.	(5) Pan proof properly.
(6) Cool oven.	(6) Maintain proper oven temperatures.

97. Color of Crust

Color of crust, sometimes called bloom, refers to the color of the top crust of a loaf of bread. The desired color is a golden brown. A satisfactory shade depends mainly upon the amount of sugar and milk present in the dough when baked and upon the temperature at which the bread was baked. The following lists will help determine the causes and remedies for poor crust color:

a. Crust Color Too Pale.

Possible cause	*Remedy*
(1) Lack of salt, sugar, milk, or diastase.	(1) Scale ingredients carefully. Adjust formula.
(2) Use of soft water.	(2) Increase salt.
(3) Old dough.	(3) Ferment dough properly.
(4) Too much dusting flour.	(4) Use dusting flour properly.
(5) Intermediate proof too long.	(5) Give proper intermediate proof.
(6) Low humidity in proofroom.	(6) Use proper humidity.
(7) Improper baking.	(7) Maintain proper oven temperature and bake for specified time.

b. Crust Too Dark.

(1) Too much sugar or milk.	(1) Adjust formula.
(2) Overmixing.	(2) Mix properly.
(3) Young dough.	(3) Ferment dough properly.
(4) Improper baking.	(4) Maintain proper oven temperature and bake for specified time. Use steam.

c. Dull Crust Color.

(1) Lack of salt.	(1) Increase salt.
(2) Lack of diastase.	(2) Increase diastatic content.
(3) Old dough.	(3) Ferment dough properly.
(4) Excess dusting flour.	(4) Use less dusting flour.
(5) Proofroom temperature too high.	(5) Lower temperature of proofroom.
(6) Low even temperature.	(6) Maintain proper oven temperature and bake for specified time.
(7) Improper use of steam.	(7) Use some steam but do not allow pressure to exceed 5 pounds.

d. Top Crust Spotted.

(1) Improper mixing.	(1) Mix according to directions.
(2) Excess dusting flour.	(2) Use less dusting flour.
(3) Condensation in proofroom.	(3) Lower humidity.
(4) Water from steam pipes in oven.	(4) Drain water from oven.

98. Symmetry of Form

Symmetry of form means the extent to which the exterior of the loaf conforms with the standards for an attractive product. Some factors which detract from symmetry are too sharp or excessively rounded corners, protruding sides, sunken sides, flat top, and humpbacked top. The more common faults of symmetry are listed below with their possible causes and suggested remedies:

a. Loaf Burst On Side.

Possible cause	*Remedy*
(1) Overmixed dough.	(1) Mix dough properly.
(2) Improper molding.	(2) Mold properly.
(3) Short pan proof.	(3) Lengthen pan proof.
(4) Oven too hot.	(4) Maintain proper oven temperature.

b. Flat Top and Sharp Corners.

(1) New flour.	(1) Age flour.
(2) Lack of salt.	(2) Increase salt.
(3) Slack dough.	(3) Reduce percentage of water.
(4) Overmixing.	(4) Mix properly.
(5) Young dough.	(5) Ferment dough properly.
(6) Excess moisture in proofroom.	(6) Lower humidity.

c. Poorly Shaped Loaf.

(1) Poor molding or panning.	(1) Make up properly.
(2) Lengthy pan proof.	(2) Give proper pan proof.
(3) Rough handling.	(3) Handle carefully.

d. Cracking of Crust or Blisters On Crust.

(1) Lack of diastase.	(1) Increase diastatic content.
(2) Too slack dough.	(2) Reduce percentage of water.
(3) Improperly mixed dough.	(3) Mix properly.
(4) Dough too old or too young.	(4) Ferment dough properly.
(5) Rough handling or improper machining.	(5) Make up properly.
(6) Improper atmospheric conditions in proofroom.	(6) Maintain proper humidity and temperature in proofroom.
(7) Cool oven or too much top heat.	(7) Use dampers properly and maintain proper oven temperature.
(8) Cooling too rapidly.	(8) Cool gradually.

99. Evenness of Bake

Evenness of bake means the extent to which all sides of the loaf are the same color or shade. Excessive heat in the top of the oven or very young dough will result in a loaf with a dark top, pale sides, and pale bottom. Too much or too little grease in the pan will have a bad effect on the color of the sides and bottom of the loaf. Too much heat in the bottom of the oven will cause the bottom of the loaf to burn before the top crust has attained the desired color.

If pans are not properly burned in or are improperly spaced in the oven, the sides of the loaf will be pale.

100. Character of Crust

Character of crust means the physical condition of the crust, such as tenderness, toughness, thickness, thinness, smooth surface, rough surface, brittleness, or rubberiness. Except in field bread, it is usually desirable to obtain a tender, thin, smooth-surfaced crust. Character of crust is usually determined by pressing it with the thumb to determine thickness and rubbery or brittle texture, and by tasting to determine tenderness or toughness. The following are common crust faults:

a. Crust Too Thick.

Possible cause	*Remedy*
(1) Insufficient shortening, sugar, or milk.	(1) Scale ingredients properly. Adjust formula.
(2) Lack of diastase.	(2) Increase diastatic content.
(3) Improper mixing.	(3) Mix properly.
(4) Old dough.	(4) Ferment dough properly.
(5) Unsatisfactory condition of pans.	(5) Have pans at correct temperature and properly greased.
(6) Improper atmospheric condition in proofroom.	(6) Maintain proper humidity and temperature in proofroom.
(7) Improper baking.	(7) Maintain proper over temperature, and bake for specified times. Use steam.

b. Crust Tough.

Possible cause	*Remedy*
(1) Dough too old or too young.	(1) Ferment dough properly.
(2) Improper mixing.	(2) Mix properly.
(3) Dough pan proofed too long or under improper conditions.	(3) Pan proof according to directors.
(4) Oven too cold or too much steam used.	(4) Maintain proper oven-temperature. Decrease steam.

101. Break and Shred

Break and shred means the extent to which the sides and ends are separated from the top crust and the presence or absence of shred in the break. The ideal condition is an even, well-shredded break on the sides and ends of the loaf. Common faults are uneven break, wild break, break on one side only, shell crust, break without shred. The following hints are helpful in correcting faults of break and shred:

a. Lack of Break and Shred.

Possible cause	*Remedy*
(1) Excess diastase.	(1) Decrease amount of malt or use nondiastatic malt.
(2) Use of soft water.	(2) Increase salt.
(3) Extremely slack dough.	(3) Low percentage of water.
(4) Dough too young or too old.	(4) Ferment dough properly.
(5) Improper pan proof.	(5) Pan proof for proper time under proper temperature and humidity.
(6) Oven too hot or too dry.	(6) Maintain proper oven temperature. Use proper amount of steam.

b. Shell Tops.

Possible cause	*Remedy*
(1) Green or new flour.	(1) Age flour.
(2) Lack of diastase in flour.	(2) Increase diastatic content.
(3) Stiff dough.	(3) Increase percentage of water.
(4) Dough too young.	(4) Ferment dough properly.
(5) Too short a pan proof or low humidity in proofroom.	(5) Pan proof for the proper time under prescribed humidity.
(6) Improper baking.	(6) Maintain proper oven temperature. Use steam.

102. Grain

Some bakers prefer a very close grain in bread while others prefer an open, fluffy grain. For Army baking, especially for garrison bread, a grain midway between the very close and the open grain is desired.

a. Close Grain. Too close a grain is generally caused by underproofing or using too much dough in each loaf. This is corrected by giving the dough a longer pan proofing or by properly scaling the dough.

b. Open Grain. Too open a grain is generally due to incorrect fermentation. If the fermentation period is too short, the open grain is due to thick cell walls caused by the gluten being insufficiently matured to form thin cell walls. When the fermentation period is too long, the cell walls break, which causes two or more cells to combine and form a large cell. Other factors which may contribute to an open grain and their suggested correction follow:

Possible cause	*Remedy*
(1) Too much or too little diastase.	(1) Correct by changing malt content.
(2) Use of extremely hard or alkaline water.	(2) Treat water as prescribed.
(3) Slack or extremely stiff dough.	(3) Use the correct amount of water.
(4) Improper mixing.	(4) Mix dough properly.
(5) Dough too young or too old.	(5) Ferment dough properly.
(6) Too much intermediate proof.	(6) Shorten intermediate proof.

Possible cause	Remedy
(7) Improper pan proof.	(7) Pan proof for the proper time with the specified temperature and humidity.
(8) Oven too cold.	(8) Maintain correct oven temperature.

103. Color of Crumb

The ideal color for the crumb of white bread is a creamy white. Chalky whites and yellows are indicative of inferior flours, while gray, dark, streaked, or spotted crumb may be due to inferior flour, dirty bread, or improper baking. Following are details of crumb color faults and their suggested corrections:

a. Gray Crumb.

Possible cause	Remedy
(1) Too much malt.	(1) Reduce malt content.
(2) Overmix dough.	(2) Mix properly.
(3) Old dough.	(3) Ferment dough properly.
(4) Pans too hot or too greasy.	(4) Use cool pans properly greased.
(5) Excessive pan proofing.	(5) Pan proof properly.
(6) Oven too cold.	(6) Maintain proper oven temperature.

b. Streaky Crumb.

(1) Slack or extremely stiff dough.	(1) Determine and use the correct percentage of water.
(2) Improper mixing.	(2) Incorporate dry ingredients, water, and yeast as prescribed.
(3) Excessive dusting flour, trough grease, or divider oil.	(3) Use these items correctly.
(4) Improper adjustment of molder rolls or molder drum.	(4) Set the molder adjustments correctly.
(5) Excessive moisture in proofroom.	(5) Maintain proper humidity in proofroom.
(6) Rough handling at oven.	(6) Handle carefully.

104. Texture

a. The texture of bread may be determined by running the tips of the fingers lightly over the surface of a slice or by rubbing the cut surface gently along the cheek. The ideal texture is soft and velvety without weakness or doughiness. Undesirable characteristics are crumbliness, roughness, lack of elasticity, and inability to resume original shape when side or top is pressed.

b. Causes of poor texture and their suggested remedies follow:

Possible cause	Remedy
(1) Alkaline or extremely hard water.	(1) Condition water as prescribed.
(2) Too slack or too stiff a dough.	(2) Determine and use the correct percentage of water.
(3) Diastatic content too high.	(3) Decrease malt or use nondiastatic malt.
(4) Lack of shortening.	(4) Increase shortening.
(5) Improper mixing.	(5) Mix dough properly.
(6) Dough too young or too old.	(6) Ferment dough properly.
(7) Excessive use of dusting flour, trough grease, or divider oil.	(7) Use these items properly.
(8) Improper pan proofing.	(8) Pan proof for the proper time with the specified humidity and temperature.

105. Aroma and Taste

Aroma and taste are closely related and together make up what is commonly called the flavor of the bread. The desirable flavor of a loaf of bread may be described as a wheaty taste, slightly sweet and pleasant. An acetic or sour flavor is the result of too long fermentation or fermentation at too high a temperature. Common faults of aroma and taste include:

a. Cheesy Flavor.

Possible cause	Remedy
(1) Inferior milk.	(1) Use good milk.
(2) Too slow fermentation of milk-containing dough.	(2) Make fermentation more rapid.

b. Rancid Flavor.

(1) Rancid shortening.	(1) Use good shortening.
(2) Use of rancid pan grease.	(2) Use good pan grease.
(3) Use of dirty grease rags.	(3) Use clean rags.

c. Flat Taste.

(1) Too little salt.	(1) Increase salt ingredient.
(2) Use of inferior salt.	(2) Use good salt.

d. Moldy or Ropy Aroma.

(1) Unsanitary storage of ingredients.	(1) Store properly.
(2) Dirty pans, unsanitary make-up equipment, troughs, or racks.	(2) Clean pans and equipment thoroughly.
(3) Rope in bread.	(3) Eliminate rope.

106. Other Common Faults and Remedies

There are some common bread faults which detract from the quality of the bread and should be eliminated, but which are not readily classified. These faults, their possible causes, and their remedies are listed below:

a. HOLES IN BREAD.

Possible cause	Remedy
(1) Use of wet or lumpy flour.	(1) Sift flour thoroughly.
(2) Excess or lack of diastase.	(2) Adjust malt content.
(3) Soft, alkaline, or extremely hard water.	(3) Condition water as prescribed.
(4) Dough too slack or too stiff.	(4) Determine and use the correct percentage of water.
(5) Improper incorporation of shortening.	(5) Incorporate as prescribed. Soften hard shortenings before mixing.
(6) Overmixed or undermixed dough.	(6) Mix dough properly.
(7) Dough too young or too old.	(7) Ferment dough properly.
(8) Too much dusting flour, trough grease, or divider oil used.	(8) Use these items properly.
(9) Improper molder adjustment.	(9) Adjust molder properly.
(10) Improper proofing.	(10) Proof the correct time under prescribed humidity and temperature.
(11) Cool oven.	(11) Maintain proper oven temperature.

b. BREAD CAVE-IN.

Possible cause	Remedy
(1) Extremely old dough.	(1) Ferment dough properly.
(2) Pans not properly prepared or spaced.	(2) Use properly greased and burned-in pans. Space as prescribed.
(3) Loaves overproofed.	(3) Pan proof properly.
(4) Improper baking.	(4) Maintain proper oven temperature.

c. HOLLOW BOTTOMS.

Possible cause	Remedy
(1) Dough overmixed or undermixed.	(1) Mix dough properly.
(2) Wet, hot, or ungreased pans.	(2) Prepare pans properly.
(3) Excessive moisture in proofroom.	(3) Maintain proper humidity.

CHAPTER 5

ROPE AND MOLD

Section I. ROPE

107. Description of Rope

a. Rope, a plant disease affecting bread, is due to the infection of the bread by the rope bacillus (bacillus mesentericus). Bread diseased with rope has an unpleasant odor similar to that of an overripe cantaloup. In addition to the odor, rope causes the crumb of the loaf to deteriorate. (See fig. 9.) The crumb gradually darkens to a deep brown and the bread becomes sticky and viscous. If the crumb is pressed together and pulled apart, it will stretch into long, silky, weblike threads. (See fig. 10.)

b. Rope bacteria exist in either of the following forms:

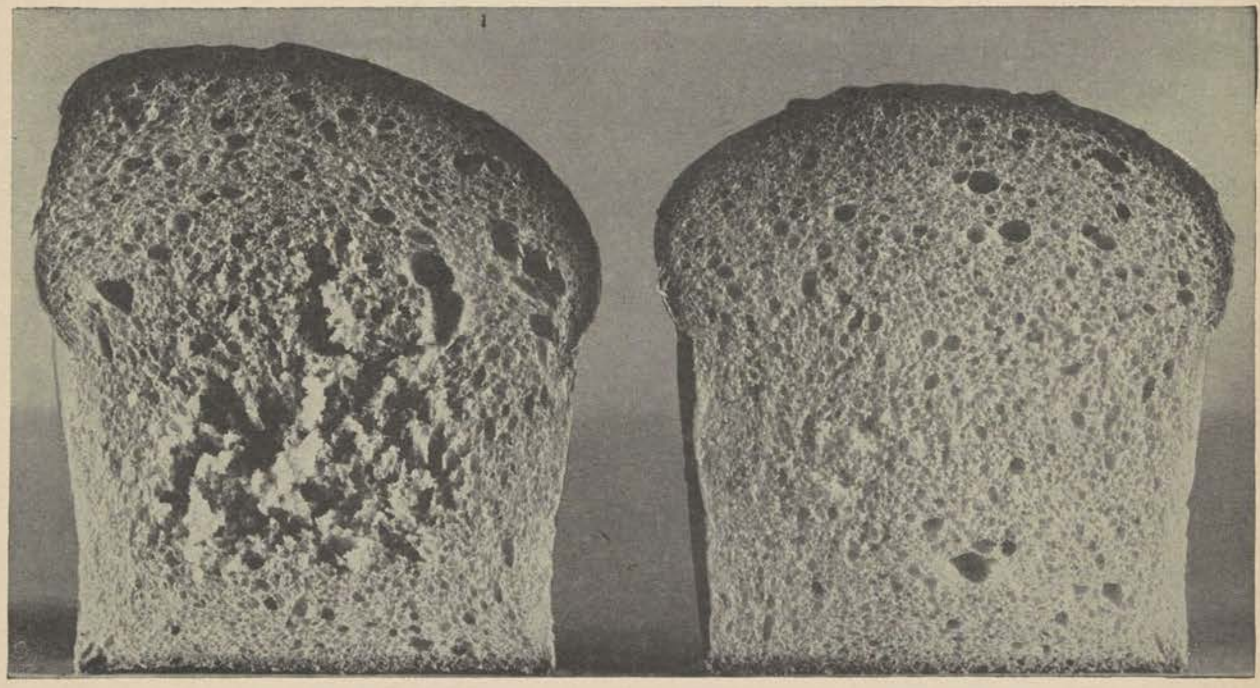
(1) *Vegetative cells.* These are the active growing cells. They are sensitive to high temperatures and many of them are destroyed during baking. However, under certain conditions, some of them are converted into spores which may survive oven temperature.

(2) *Spores.* Spores are the vegetative cells in a dormant state. They are more resistant to high temperatures than the vegetative form.

108. Source of Rope

a. HABITAT OF ROPE GERMS. Rope germs are present in the soil and in the air, and are frequently found on the outer parts of vegetables and grains. They may attach themselves to dust particles and be carried great distances. They may be on the ingredients used in bread making, but are more likely to be on bakery equipment.

b. CONTAMINATION OF BREAD. Rope bacteria contaminate bread on the "dough side" of the oven; that is, they get into the dough anywhere in the baking process from the mixer to the oven. Very rarely are they placed in the bread after baking, although



Ropy Loaf *Normal Loaf*

Figure 9. Rope causes the crumb to become soft and sticky.

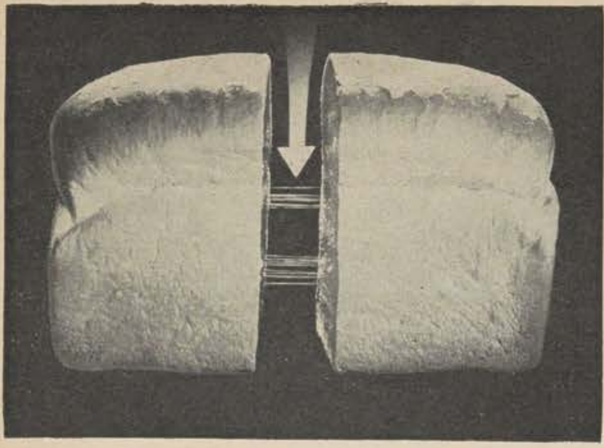


Figure 10. The long silky threads are a sure sign of rope-infected bread.

instances are known of rope infection of bread from the blades of a bread-slicing machine.

109. Detecting Rope

In hot, humid weather every baker should keep a sharp lookout for the appearance of rope. The simplest method is to select three or four loaves from each day's baking and store them in a moist, warm place at a temperature of 90° to 95° F. One loaf should be cut 12 hours after baking; another, about 24 hours; and the third, about 48 hours. If rope odor or other symptoms are present, control measures should be immediately instituted.

110. Preventing Rope

It is much better to prevent the infection of bread by rope than to wait until the disease appears and then try to wipe it out. As rope preventive measures, the following precaution should be taken, especially during the summer months:

a. VINEGAR. Vinegar is one of the most common rope inhibitors available to the Army baker. It should be used as a precautionary measure during the summer months. One-half of 1 percent of 100-grain vinegar added to the formula is the amount recommended. Ordinary table vinegar is 40- to 45-grain only and, if it is the only type of vinegar available, twice as much (1 percent) must be used. When vinegar is used, the water ingredient must be reduced by the amount of the vinegar. That is, if the formula calls for 60 percent water and 0.5 percent vinegar is used, only 59.5 percent of water must be used or the dough will be a little slack. The exact amount of vinegar is variable, depending upon the number of rope spores present, the moisture content of the bread, the conditions under which the bread is stored, and the richness of the formula used. Baking tests may be necessary in order to determine the exact amount to use to produce bread of the highest quality.

b. CLEANLINESS. Machines, floors, walls, ceilings, coolers, refrigerators, proofrooms, bread pans and boxes, and other bakery and delivery equipment must be clean. Remember that the bread can be infected with rope at any stage on the dough side of the oven.

c. DISPOSAL OF STALE BREAD. Any stale bread in the bakery must be disposed of immediately after discovery. One loaf badly infected with rope contains enough bacteria to infect at least 60,000,000 loaves of bread.

d. RAW MATERIAL STORAGE. Proper conditions for the storage of raw materials must be maintained. Dampness and warmth due to poor ventilation provide excellent conditions for the growth and reproduction of rope bacteria.

e. FERMENTATION. Sufficient yeast should be used to assure a vigorous, healthy fermentation and conditioning of the dough. The acidity produced during fermentation will help to prevent the growth of rope bacteria.

f. ACIDITY CONTROL. Rope bacteria will not develop if the dough is sufficiently acid. If the vinegar or increased fermentation reduces the pH value (normally 5.7 to 5.4) to 5.15 or lower, rope growth will be retarded.

g. CONDITION OF DOUGHS. Throughout the summer months, doughs should be set stiffer than usual. Dough temperature should be maintained at 77° to 80° F. Slightly longer fermentation periods are desirable.

h. THOROUGH BAKING. Thorough baking will not prevent rope, but in many cases it will retard rope development, especially when there are only a small number of rope organisms present.

111. Rope Control

If rope appears in bread in spite of preventive measures, the following steps must be taken:

a. Make certain all of the precautionary measures outlined in paragraph 110 are being followed.

b. Double the amount of vinegar used. Use 1 percent of 100-grain vinegar or 2 percent of table vinegar with the formula.

c. Sterilize floors by washing with a formaldehyde solution of 1 part standard formaldehyde (40 percent USP) and 150 parts hot water. This solution is a poison and after sterilization the floors must be thoroughly rinsed with hot water. The solution will not rust metal equipment.

d. Wash all equipment with a strong solution of vinegar and water. This is an important step in killing rope spores. Mopping the floors with a vinegar solution is also helpful.

c. As a last resort, the bakery installation should be fumigated with formaldehyde. Fumigation should be under the supervision of the proper medical or chemical warfare authorities.

Section II. MOLD

112. Description of Mold

Molds are tiny plants visible to the naked eye. (See fig. 11.) There are many types of mold, differing not only in form but also in color, ranging from red to blue. They form velvety, colored spots on bread crust, create a musty odor, and eventually cover the entire loaf. At the same time the mycelium (hairlike body) grows into the loaf forming separate plants in the pores and spoiling the whole crumb. (See fig. 12.)

113. Source of Mold

a. Although the mold plant is visible to the naked eye, its spores, like rope organisms and spores, are visible only with the aid of a microscope. These mold spores are present in the air practically everywhere, waiting only to find the proper conditions of food, warmth, and moisture in order to develop into mold plants.

b. Unlike rope spores, mold spores do not ordinarily survive bread-baking temperatures. Bread comes from the oven free from mold and must be infected on the "bread side" of the oven. Therefore the source of mold is very rarely the bread

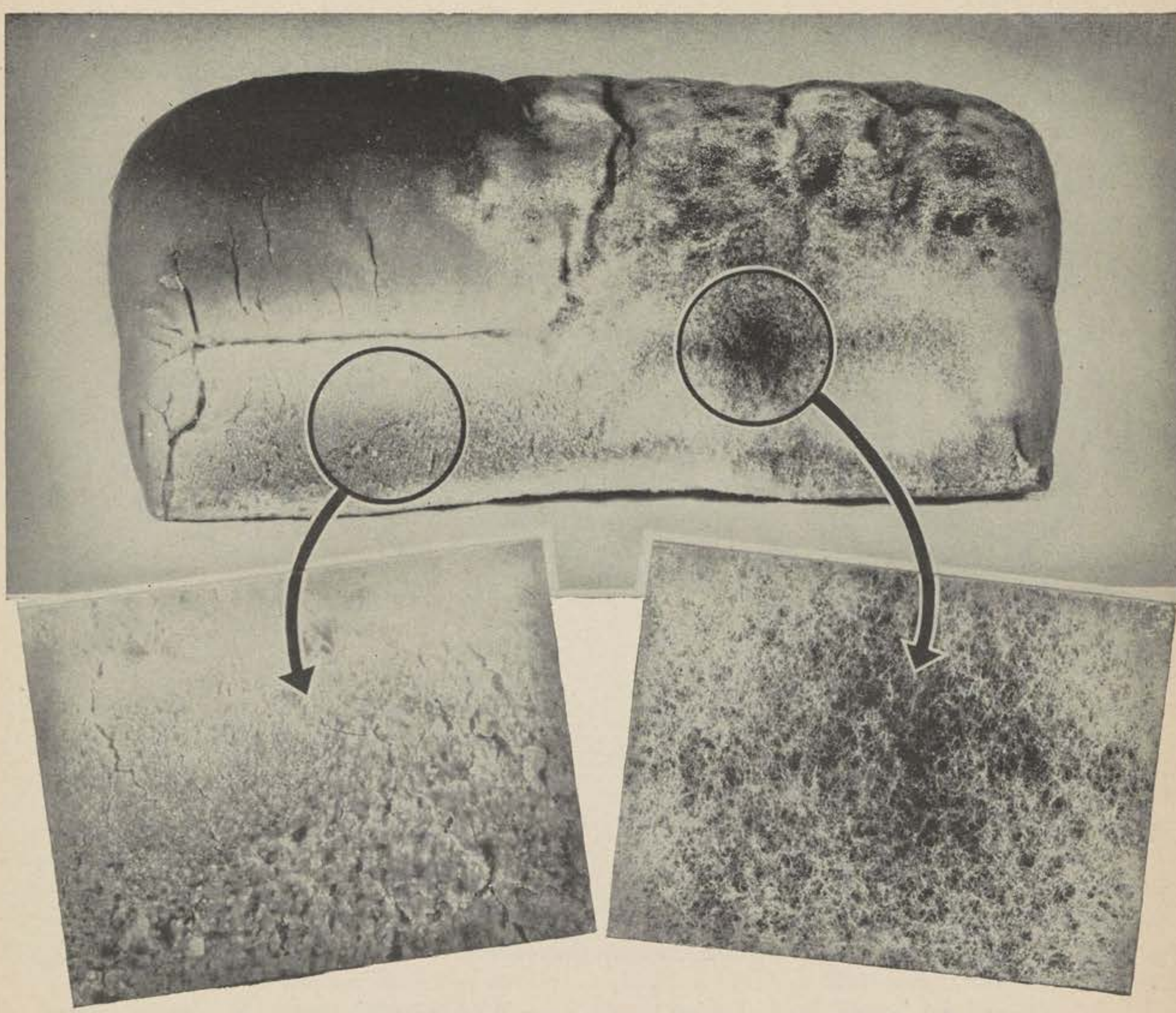


Figure 11. To the naked eye, mold looks like a velvety covering for the bread.

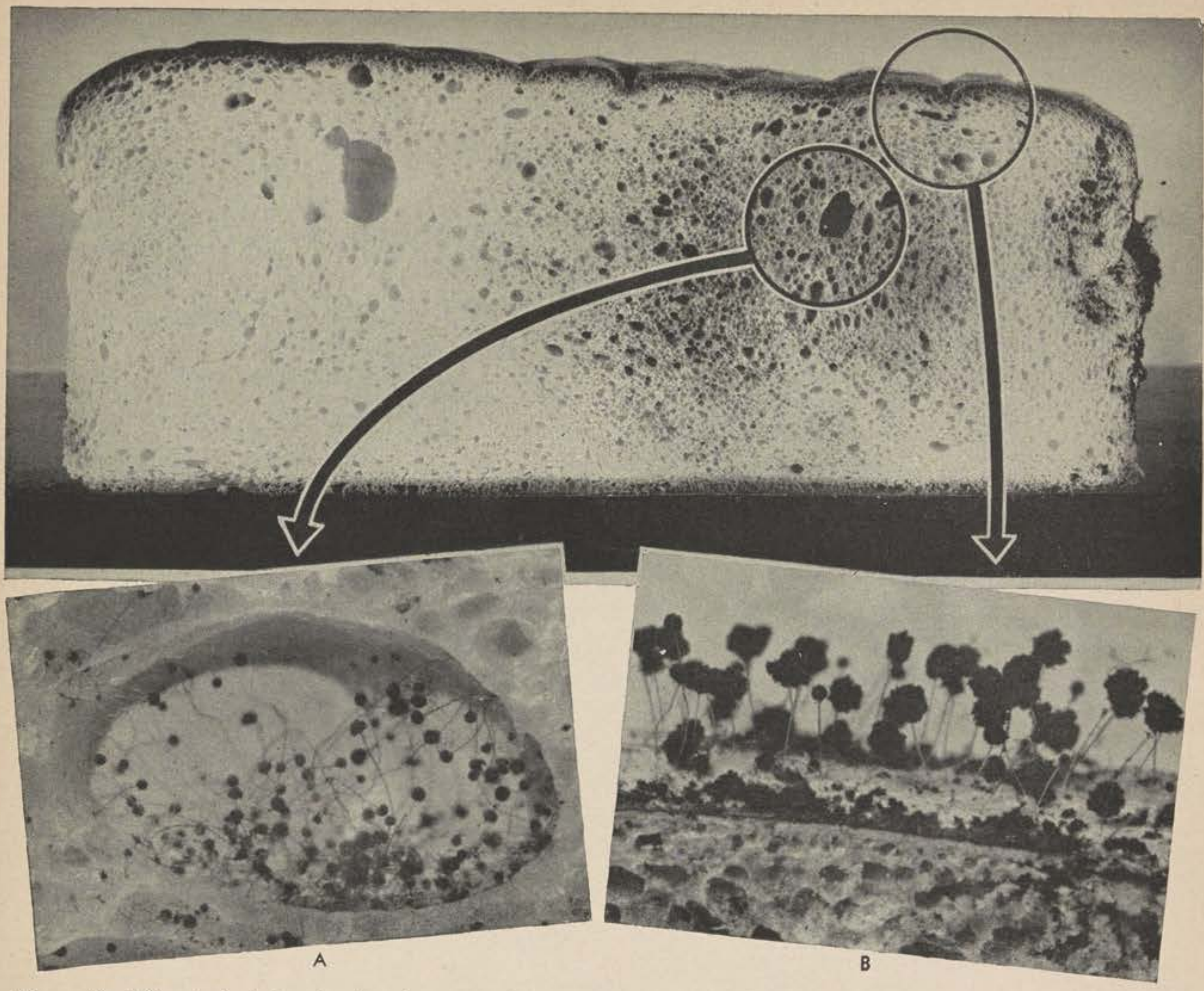


Figure 12. When looked at under the microscope, the tiny mold plants are clearly visible. The mycelium grows down into the crumb as shown in A.

ingredients or the equipment used in the preparation of dough. A principal source of infection, however, is dirty equipment used for the cooling, storing, or transporting of bread. Other dangerous areas for mold growth are stale bread and spoiled food of any kind. Consequently, because bread does provide a suitable type of food for the development of molds, particularly in hot, humid weather, precautions must be taken to prevent the spores from coming into contact with bread.

114. Preventing Mold

To prevent mold trouble, especially during the summer months, the following precautions should be taken:

a. CLEANLINESS. All equipment on the "bread side" of the oven must be spotlessly clean. Cleansing agents such as washing soda, trisodium phosphate, and sodium hypochlorite may be used. The high degree of alkalinity of these products kills any spores with which they come in contact. Dust must be kept down by careful cleaning, screening, and air conditioning wherever possible. Debris, unwashed sacks, old bread, and other materials that provide possible places for mold growth should be disposed of in the approved manner as soon as possible.

b. VENTILATION AND SUNLIGHT. Ventilation and sunlight discourage the growth of mold.

c. BAKING AND COOLING. Because moist crust makes an ideal food for mold growth, bread should be thoroughly baked. It should be cooled, whenever possible, in an air-conditioned room so that the air will be free from mold. The time of cooling should be controlled, and the loaf should be cooled to an inside temperature of 90° F. or lower before it is issued or stored.

DRY AND LIQUID MEASURES

DRY MEASURE

2 pints = 1 quart = 1.101 liters.
8 quarts = 1 peck = 8.811 liters.
4 pecks = 1 bushel = 35.24 liters.

LIQUID MEASURE

4 gills = 1 pint = 473.25 cubic centimeters.
2 pints = 1 quart = 0.9465 liters.
4 quarts = 1 gallon = 3.786 liters.
31½ gallons = 1 barrel.
2 barrels = 1 hogshead.

LIQUID MEASURE CONVERSION TABLE (UNITED STATES, IMPERIAL, AND METRIC MEASURES)

	United States measure				Imperial measure (British)				Metric measure		Weight of indicated volume of water	
	Gallon	Quart	Pint	Gill	Gallon	Quart	Pint	Gill	Liter	Cubic centimeter	Pound (avoirdupois)	Kilogram
UNITED STATES MEASURE												
1 gallon	1	4	8	32	0.833	3.33	6.66	26.66	3.785	3,785.4	8.33	3.785
1 quart	.25	1	2	8	.208	.833	1.666	6.67	.946	946.4	2.08	.946
1 pint	.125	.5	1	4	.104	.417	.833	3.33	.473	473.2	1.04	.473
1 gill	.031	.125	.25	1	.026	.104	.208	.833	.118	118.3	.26	.118
IMPERIAL MEASURE (BRITISH)												
1 gallon	1.2	4.8	9.6	38.4	1	4	8	32	4.543	4,543.5	10	4.543
1 quart	.3	1.2	2.4	9.6	.25	1	2	8	1.136	1,135.9	2.5	1.136
1 pint	.15	.6	1.2	4.8	.125	.5	1	4	.568	567.9	1.25	.568
1 gill	.038	.15	.3	1.2	.031	.125	.25	1	.142	142.0	.312	.142
METRIC MEASURE												
1 liter	.264	1.057	2.11	8.45	.220	.880	1.761	7.044	1	1,000	2.20	1
1 cubic centimeter	.0003	.001	.002	.008	.0002	.0009	.002	.007	.001	1	.002	.001

CONVERSION OF OTHER FORMS OF MILK TO APPROXIMATE EQUIVALENTS IN LIQUID WHOLE MILK

Liquid whole milk (lb.)	Evaporated milk		Dry whole milk				Dry skim milk					
	Milk (14½-oz.) cans	Water (lb.)	Milk (whole dry)		Water		Milk (dry skim)		Butter or shortening		Water	
			Pound	Ounce	Pound	Ounce	Pound	Ounce	Pound	Ounce	Pound	Ounce
2.1 (1 qt.)	1	1	....	4	1	12	....	3	....	1	1	14
5	4½	4	1	....	4	....	....	12	....	4	7	6
8.6 (1 gal.)	2½	2½	....	10	4	6	....	7	....	3	4	6
10	5½	5	1	3	8	13	....	14	....	6	8	12
20	11	10	2	6	17	10	1	12	....	11	17	9
30	16½	15	3	9	25	7	2	10	1	....	26	6
40	22	20	4	12	35	4	3	8	1	6	35	2
50	27½	25	5	15	43	1	4	6	1	12	43	14
60	33	30	7	2	51	14	5	5	2	1	52	10
70	38½	35	8	5	60	11	6	3	2	6	61	7
80	44	40	9	12	70	4	7	1	2	12	70	3
90	49½	45	10	14	79	2	8	....	3	2	78	14
100	55	50	12	....	88	....	9	....	3	8	87	8

APPENDIX II

MEASURES OF TEMPERATURE

CONVERSION OF FAHRENHEIT DEGREES TO CENTIGRADE DEGREES OF TEMPERATURE

Fahrenheit	*Centigrade*	*Fahrenheit*	*Centigrade*
0	—17.8	85	29.4
10	—12.2	90	32.2
15	— 9.4	95	35.0
20	— 6.7	100	37.8
32	0	110	43.3
35	1.7	120	48.9
40	4.4	150	65.6
45	7.2	200	93.3
50	10.0	212	100.0
55	12.8	250	121.1
60	15.6	300	148.9
65	18.3	350	176.7
70	21.1	400	204.4
75	23.9	450	232.2
80	26.7	500	260.0

Rule. Subtract 32 from Fahrenheit degrees, and multiply the remainder by 5/9. The product is the equivalent in Centigrade degrees.

CONVERSION OF CENTIGRADE DEGREES TO FAHRENHEIT DEGREES OF TEMPERATURE

Centigrade	*Fahrenheit*	*Centigrade*	*Fahrenheit*
0	32	50	122
10	50	75	167
15	59	100	212
20	68	125	257
25	77	150	302
30	86	175	347
35	95	200	392
40	104	225	437
45	113	250	482

Rule. Multiply Centigrade degrees by 9/5 and add 32. The product is the equivalent in Fahrenheit degrees.

CONVERSION OF WEIGHTS

CONVERSION OF AVOIRDUPOIS TO METRIC SYSTEM OF WEIGHTS

Avoirdupois		*Metric*	
Pound	*Ounce*	*Gram*	*Kilogram*
1	16	453.6	0.454
0.0625	1	28.35	0.0283

Note. For practical calculations use 453 grams as equal to 1 pound, and 28 grams as equal to 1 ounce.

CONVERSION OF OUNCES (AVOIRDUPOIS) TO POUNDS (FRACTIONAL AND DECIMAL)

Ounces	*Pounds*		*Ounces*	*Pounds*	
	(Fractions)	*(Decimals)*		*(Fractions)*	*(Decimals)*
1	1/16	0.0625	15	15/16	0.938
2	1/8	0.125	16	1	1.000
3	3/16	0.188	17	1 1/16	1.063
4	1/4	0.25	18	1 1/8	1.125
5	5/16	0.313	19	1 3/16	1.188
6	3/8	0.375	20	1 1/4	1.25
7	7/16	0.438	30	1 7/8	1.875
8	1/2	0.5	40	2 1/2	2.5
9	9/16	0.563	50	3 1/8	3.125
10	5/8	0.625	60	3 3/4	3.75
11	11/16	0.688	70	4 3/8	4.375
12	3/4	0.75	80	5	5.000
13	13/16	0.813	90	5 5/8	5.625
14	7/8	0.875	100	6 1/4	6.25

Note. To change pounds to ounces multiply by 16. To change ounces to pounds divide by 16. For any number of ounces or pounds not listed above, add two or more numbers listed above which will equal the given number and then add the corresponding equivalents.

WEIGHTS OF WATER AND THEIR EQUIVALENTS

Weight	*Equivalent in measure*
1 pound (approx.)	1 pint
2 pounds 1 1/3 ounces (approx.)	1 quart
8.35 pounds (approx.)	1 gallon
20 pounds 14 ounces	10-quart pail
25 pounds	12-quart pail
29 pounds 3 ounces	14-quart pail

WEIGHTS OF BAKING INGREDIENTS CONTAINED IN NO. 56 DIPPER (1 QUART), CANTEEN CUP, AND MESS-KIT SPOON (All Measurements level)

Ingredient	*No. 56 Dipper (1 quart)*	*Canteen cup*	*Mess-kit spoon (tablespoon)*
Flour	1 pound 5 ounces	1 pound	⅓ ounce
Water	2 pounds	1½ pounds	½ ounce
Yeast (compressed)			½ ounce
Yeast (active dry)			⅓ ounce
Salt	2 pounds 9 ounces	2 pounds	⅔ ounce
Sugar	2 pounds	1½ pounds	½ ounce
Shortening	2 pounds	1½ pounds	½ ounce
Dry skim milk	1 pound 5 ounces	1 pound	⅓ ounce

MINERAL SUBSTANCES IN WATER AND THEIR EFFECT ON BREAD

Type of water	*Substance present*	*Effect*	*Remedy*
Soft	Mineral free	Softens gluten, makes sticky dough	Use mineral yeast food or more salt
Temporarily hard	Calcium iron, magnesium, bicarbonate	Retards fermentation	Boil, filter, use vinegar
Permanently hard	Calcium or magnesium sulfates	Retards fermentation and toughens gluten	Use more yeast, filter
Saline	Sodium chloride (common salt)	Taste	Reduce salt slightly or distill
....	Iron	Color	Filter
....	Sulfur	Taste	Aerate filter
Alkaline	Alkali such as sodium carbonate	Slows fermentation; bad taste	Use vinegar, lactic acid, or more yeast
Acids	Acid	Hastens fermentation	Filter through limestone
....	Sulfides	Dissolve gluten	Distill
....	Manganese	Sludge in pipes	Filter
....	Suspended matter	Cloudiness, dirt	Filter
....	Organic matter and bacteria	Unsafe for human consumption	Chlorinate

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