Bulletin No. 242 - Making White and Whole Wheat Bread with Three Types of Yeast and Hard Wheat Flour

University of Wyoming Agricultural Experiment Station

Follow this and additional works at: https://repository.uwyo.edu/ag_exp_stabulletins

Part of the Agriculture Commons

Publication Information

This Full Issue is brought to you for free and open access by the Agricultural Experiment Station at Wyoming Scholars Repository. It has been accepted for inclusion in Wyoming Agricultural Experiment Station Bulletins by an authorized administrator of Wyoming Scholars Repository. For more information, please contact scholcom@uwyo.edu.
Made from:
1. Fresh compressed yeast.
2. Compressed yeast frozen four months.

Making White and Whole Wheat Bread with Three Types of Yeast and Hard Wheat Flour

Bulletins will be sent free upon request.
Address: Director of Experiment Station, Laramie, Wyoming.
UNIVERSITY OF WYOMING
Agricultural Experiment Station

BOARD OF TRUSTEES

Officers:
WALLACE C. BOND, President
D. P. B. MARSHALL, Vice President
VICTOR J. FACINELLI, Treasurer
FAY E. SMITH, Secretary

Executive Committee:
WALLACE C. BOND
HARRIETT T. GRIEVE
VICTOR J. FACINELLI
RALPH S. LINN

Appointed Members Term Expires
1925. HARRIETT T. GRIEVE 1943
1929. WALLACE C. BOND 1941
1935. D. P. B. MARSHALL 1941
1936. EVELYN S. PLUMMER 1941
1937. VICTOR J. FACINELLI 1943
1937. RALPH S. LINN 1943
1939. FRANK A. BARRETT 1945
1939. PETER SILL 1945
1939. MILWARD L. SIMPSON 1945

NELS H. SMITH, Governor of Wyoming Ex Officio
ESTHER L. ANDERSON, State Superintendent of Public Instruction Ex Officio
A. G. CRANE, Ph.D., President of the University Ex Officio

STATION STAFF

Administration:
A. G. CRANE, Ph.D., President.
J. A. HILL, B.S., Dean of College of Agriculture; Director of Station.
W. L. QUAYLE, B.S., Director Experiment Farms.
MARGARET LAMB, B.S., Station Clerk.

Agronomy and Agricultural Economics:
A. F. VASS, Ph.D., Agronomist.
F. L. HARTMAN, M.S., Assoc. Agronomist.
T. J. DUNNEWALD, M.S., Asst. Soil Investigations.
G. H. STARR, Ph.D., Assoc. Agronomist; Plant Pathologist.
W. A. RIEDEL, M.S., Asst. Agronomist.
EDWARD J. TALBOT, M.S., Asst. Economist.
DELMIN M. STEVENS, B.S., Asst. Economist.
ROBERT LANG, B.S., Asst. Agronomist.
ROBERT F. ESBLICK, B.S., Asst. Agronomist.

Animal Production:
FREDRIC S. HULTZ, Ph.D., Animal Husbandman, Beef Cattle, Sheep.

Apiculture and Entomology:
* A. P. STURTEVANT, Ph.D., Assoc. Apiculturist, in Charge U. S. Bee Culture Field Station.
* A. W. WOODBOW, Ph.D., Asst. Apiculturist.
* E. C. HOLST, Ph.D., Asst. Bacteriologist.
* J. D. HITCHCOCK, M.A., Junior Apiculturist.

*In cooperation with U. S. Department of Agriculture.
†Mr. Marshall also served from 1923 to 1929.

Botany:
AVEN NELSON, Ph.D., Botanist and Horticul-
turist.

Chemistry:
O. A. BEATH, M.A., Research Chemist.
O. C. McCREARY, Ph.D., Assoc. Research Chemist.
H. F. EPPSON, M.S., Asst. Chemist.
WILLIAM B. BRADLEY, Ph.D., Asst. Pharma-
coologist.

Home Economics:
ELIZABETH J. McKITTRICK, M.S., Home Econom-
ics.
EMMA J. THIESSEN, M.A., Asst. Home Econom-
ics.

Library:
MARY E. MARKS, B.L.S., Librarian.

Veterinary Science and Bacteriology:
* MARY E. TURNER, Ph.D., Technician.

Weather:
FRANK E. HEPNER, M.S., Head of Weather Station.

Wool:
J. A. HILL, B.S., Wool Specialist.
ROBERT BURNS, Ph.D., Wool Specialist.
ALEXANDER JOHNSTON, M.S., Asst. Wool Specialist.

Zoology:
JOHN W. SCOTT, Ph.D., Zoologist and Para-
sitologist.
RALPH HONESS, M.A., Asst. Research Zoologist.

†On leave.
Making White and Whole Wheat Bread with Three Types of Yeast and Hard Wheat Flour

By Emma J. Thiesse

Introduction

Good bread for the family is of great importance to the homemaker, whether made in the home or purchased from the baker. In cities, towns, and in the rural areas of more densely populated states, its production has been largely turned over to the commercial baker. Home baking is still one of the important concerns of the Wyoming housewife in rural districts, since ranches are often long distances from sources of supplies, and it is not always possible to purchase bread each day or week. The distinctive flavor of home-made bread is usually well liked. Any homemaker may make good bread from the excellent hard wheat flour manufactured in this state. She should recognize that back of recipes are certain scientific principles which should be respected and observed.

History and Literature

There are many factors affecting the quality of bread. Of the ingredients used, flour perhaps varies most and has been the subject of much experimental testing.

A study of the bread making properties of hard wheat flour manufactured in Wyoming has extended over a period of several years and was confined first to testing a number of brands milled from Marquis spring and Turkey Red winter wheat (1)*. Some of the flour was milled from combinations of the two wheats in equal proportions, also in the proportion of 70 per cent Marquis spring and 30 per cent Turkey Red. Others were milled entirely from Marquis spring wheat. In the samples tested, the flour from the blended varieties rated somewhat superior in bread making qualities (2).

Wyoming flour stored in a warm dry place for a period of several years was improved by aging for one to three months.

*Numbers in parenthesis refer to “Literature Cited” at the end of this bulletin.
and then showed little change for about two years. The moisture of these flours increased or decreased depending upon the relative humidity to which they were exposed. Wyoming has a low annual rainfall of 12 to 15 inches, and the average humidity at Laramie over a one-year period was 45 per cent out of doors but only 15 to 27 per cent in the steam heated storage room. The water-absorbing power of the flour increased with its age, due in a large part to the loss of moisture from the flour itself under the conditions of storage. The water absorbed was considerably less for flour from the same lot stored in tin containers which were air tight or practically so. Bread made from flour so stored was superior in quality to that from the same lot which had been stored in sacks over a period of time. Liquid was increased in the bread and pastry formulas particularly when the flour was stored in small quantities in paper or cotton sacks for a period of several months (2).

Very few experimental tests have been made on the value of different varieties of Wyoming wheat for flour. Some samples from the experiment stations at Sheridan and Archer, Wyoming, were included in a study by the United States Department of Agriculture in tests of varieties from all states. Marquis, a variety of hard spring wheat, was reported sectionally. Samples grown at Archer for the years 1917-1921 had an average of 14.2 per cent crude protein. The water absorption for the Wyoming samples was above the average for the other stations and was exceeded by only one. Loaf volume was also a little above the general average. The influence of both season and locality on water absorption was very marked as was indicated by the wide range of percentages (3). The value of a flour for bread depends upon the quality and quantity of its gluten which gives it strength. This quality is usually judged by the capacity of the flour for absorbing water; up to a certain point, the greater the water absorption the higher the quality.

Whole wheat flour may be manufactured from either hard or soft wheat. Neither contains the baking strength of white flour. Whole wheat flour made from hard spring or winter wheat yielded the most satisfactory loaves in appearance, volume, and texture (4).
Other variable factors affecting the quality of home-made bread are the age of the yeast and the fermentation of the dough. They have not been studied as extensively as flour, since the commercial baker usually has access to fresh compressed yeast and fermentation rooms in which temperature and humidity are controlled. These factors are of considerable concern to the home baker and have been given especial attention in the baking experiments at this station.

SCOPE OF THE EXPERIMENTS

The experiments reported here have been concerned with development of good formulas for home-made bread with both white and whole wheat flour, using various types of yeast, and the determination of factors contributing to variable qualities in the product. The best methods for storing yeast of different kinds have also been investigated.

The study has been divided into two parts: Part I, baking white bread with hard wheat flour by the long and short process, and various factors affecting its quality, and Part II, baking whole wheat bread using similar processes and yeasts as for the white bread. Different granulations of whole wheat flour were tested, and the best methods for using them in bread as well as the length of time they could be stored with no insect infestation were determined.

EQUIPMENT AND MATERIALS

Equipment. Standard equipment consisted of: Tin flour pans 9 x 4 x 2½ inches with covers; calibrated expansion tubes 4½ x 9 inches deep; heavy baking pans 6 x 2 inches at the bottom, 7 x 3½ inches at the top and 5½ inches deep; also an electric mixer with three speeds for mixing the dough. Other equipment comparable to that in an average home was tested. Both electric and gas ovens were used for baking. The proofing cabinet for the fermentation of the dough was electrically heated and devised so that steam might be introduced during the fermentation period.

An incubator was utilized for keeping liquid yeast and sponges at a constant temperature during the overnight fermentation.
EXPERIMENTAL DATA
PART I—WHITE YEAST BREADS

Ingredients

The ingredients in bread consist of liquid, salt, sugar, fat, yeast, and flour. In experimental baking tests at this laboratory, varied quantities of these ingredients as well as different kinds were tested in order that a high quality loaf might be developed with the hard wheat flour manufactured in the state, using both the long and short process of baking. The results secured are discussed below.

Liquid. In these experimental tests, milk and water were commonly used. Potato water was added with dry yeast. Other liquids such as whey could well be utilized, thereby conserving valuable minerals and lactose. Tap water, which contained about 200 parts per million hardness and had a pH of 7.5, was more satisfactory than distilled water in bread.

Other investigators have found that some mineral salts in the water tend to strengthen the gluten; however, an excessively hard water may retard fermentation by toughening it (6). Distilled water had a tendency to soften the gluten to the extent that the dough became somewhat sticky, and the volume of the loaf was slightly reduced. In localities where the water is very hard, it may be advisable to substitute part milk or to increase the yeast slightly. Hard waters from Gillette and Riverton, Wyoming, did not have a noticeable effect on the quality. Equal proportions of milk and water produced a lighter loaf than all milk in the long process doughs, since milk was not satisfactory in the overnight sponge or the liquid yeast. Milk and water in equal proportions gave a better textured loaf than all milk with Maca yeast in the short process doughs. Skim milk proved satisfactory. Either dried or evaporated milk may also be used diluted with water.

From a nutritive standpoint, milk should be one of the important ingredients in bread since it is very rich in calcium in which the diet is often poor.
Sugar. Sugar is used chiefly for its sweetening properties. It helps to give a golden brown color to the crust and an appetizing flavor to the bread. Sugar supplies the yeast with food, hence the amount must be sufficient to support yeast activity during the fermentation with some left over for flavor. There was usually a larger amount in the long process than in the straight doughs.

Salt. The quantity of salt in bread is most often determined by the taste and averages about one teaspoon per pound loaf. Somewhat larger amounts were used in whole wheat bread. Too much slows up the fermentation. Salt not only governs the action of the yeast but also prevents the development of objectionable bacteria or wild yeast species in the dough (6).

Fat. There seemed very little differences in the quality of the loaves in which hydrogenated fat or lard were used. Lard, which is perhaps most frequently used in rural homes, proved very satisfactory. The fat should be melted and uniformly distributed in the dough. It should be cooled until lukewarm before mixing with the yeast and flour. The average amount used in these experiments was about one tablespoon per pound loaf.

Flour. The flour for most of the tests was a brand manufactured in the state from 70 per cent Marquis spring and 30 per cent Turkey Red winter wheat. It was secured direct from the mill and was stored in tight tin containers. Several well known commercial brands of flour were also used for comparative ratings. Some of the qualities of Wyoming flour have been discussed in more detail in the section on history and literature.

Yeast. Compressed yeast and two types of dry yeast were tested. Compressed yeast remains active in the moist cakes, hence begins to grow and multiply rapidly when mixed with sugar, flour, and liquid and held under proper temperatures. It is practically the only type of yeast used by the commercial baker. It has the disadvantage of keeping for only a comparatively short time by ordinary methods of refrigeration and is, therefore, not so frequently used by the rural homemaker, particularly in isolated localities.
Maca, a dry granulated yeast which has been put on the market quite recently, is speedier than the dry cakes. It may be used like compressed yeast and can be safely stored for longer periods by ordinary methods.

Dry yeast cakes are not so convenient to use as the other forms mentioned, since long preliminary fermentation is needed before it becomes activated sufficiently to make the dough light. It has an advantage in that it can be stored for longer periods without deterioration than the others.

**EXPERIMENTAL BAKING**

*Methods of Mixing.* Two principal methods of dough mixing were used with some variations in the long process. They were:

1. The straight-dough or short process in which all the necessary ingredients were mixed in one operation and the process completed in five or six hours. The yeasts that could be used satisfactorily were compressed and Maca dry granulated.

2. The ferment-dough or long process in which dry yeast cakes were used. Water, yeast, potato, and potato water were mixed and fermented either with or without flour. The ferment was allowed to stand 12-15 hours or overnight before mixing into a dough which required about five or six additional hours for fermentation. Variations of this method which were tested were:

   (a). Thin overnight sponge—thick sponge next morning—dough, and

   (b). Liquid yeast or overnight starter which varied from the above formula in that no flour was added. This was tested:

   (1) as liquid yeast overnight thickened to dough next morning; and

   (2) liquid yeast overnight thickened to a sponge next morning and when light, thickened to a dough.

*Dough Temperatures.* The temperature of the dough was largely governed by the temperature of the liquid. The liquid should be barely lukewarm (85 to 90° F.) which, when blended with flour, will produce a dough temperature around 77 to 79° F.
The temperature at which the dough matures and rises should be fairly constant and around 80 to 85° F.

The home baker usually errs by keeping the dough too warm. The term “lukewarm” is too indefinite to be used for a satisfactory temperature for the liquid since a range from 83 to 110° F. may be classed as lukewarm. The higher temperatures in this range produced poor bread. Maintaining a moderately cool dough insures a better grain and texture in the loaf as well as flavor. A maxim of the baker is that a moderately cool dough always makes better bread (6). Facilities for cooling the dough to maintain temperatures around 80° F. are advisable during hot weather.

Fermentation of Dough. Fermentation of the dough starts as soon as it is mixed and continues until the yeast is killed in baking. Both sponge and dough reach a maximum height, which will usually be retained for a short time before the dough falls. This is called the breaking point. The dough should be turned and folded before reaching this point, which is preferable to kneading as it should be handled lightly. No flour is necessary and if added at this time usually results in streaks.

It has been evident from repeated tests with Wyoming hard wheat flours that better results were secured with longer fermentation periods than those specified in the usual directions of letting the dough double in bulk. The dough was usually allowed to treble its bulk for the first fermentation period and to rise to two and one-half times its bulk for the second and third. The expansion was measured in calibrated tubes. The greater part of the total time was taken for the first period which averaged from two to two and one-half hours. The final maturity of the dough largely depends upon the first turn. The pan proofing should be carefully gauged. If difficult to judge, the dough may be pressed with the finger, and, if an indentation remains, it has been proofed sufficiently. If overproofed there is danger of overexpansion and falling. This may also result in crumbly bread or in the upper half of the loaf becoming too porous.
Panning. Individual loaf pans are more desirable than the long shallow pans in common use by the home baker. Such pans are often used to facilitate baking more loaves at one time, since three or four may be placed side by side in the pan, producing the so-called cottage loaves. They often bake unevenly and the center loaves have a crust only on the top and bottom. In individual tins, a crust is formed on all sides, thereby keeping the bread fresh over a longer period. If long pans are used, it is advisable that the loaves be of medium size in order that they may bake more evenly.

Prevention of Crust Formation on Dough. The problem of preventing the drying and crusting of the surface of the exposed dough during the fermentation and proofing proved to be a difficult one, due to the dryness of the Wyoming atmosphere. The laboratory in which the tests were made averaged only 27 per cent in relative humidity throughout the entire year and 18 per cent during the winter months (2). If the dough was left exposed to this atmosphere, a hard dry surface quickly formed on the top, resulting in lumps and streaks within the dough when kneaded. There was a tendency when crusting occurred for ragged breaks to appear on the sides of the loaf. This was probably caused by a too rapid hardening and browning of the crust, which did not allow for expansion of gases and resulted in cracks (1). If a moderately warm moist place is not available for fermentation, the container of the dough may be kept in a pan of warm water. A preserving kettle with a rather close fitting lid provides an excellent receptacle for keeping the dough covered. After panning, the loaves may be covered with a clean towel and put in a moderately warm place to rise. A warm closed cupboard with a pan of hot steaming water placed within makes a good improvised proofing cabinet for the loaves in an arid climate.

Baking. The oven temperature and the length of time for baking depends upon the type and size of the loaf.

During the first few minutes of baking, the dough rises very rapidly. This is frequently referred to as the “oven spring.”
To check the action of the yeast and the further production of gas, the oven temperature should be around 415° F. for the first 10 minutes. It is usually advantageous, particularly with gas ovens, to lower the temperature to 375° F. for the remainder of the baking time of about 30 minutes.

Cottage loaves require somewhat lower temperatures since they are baked over a longer period. With coal or wood ranges, 375° F. for the first fifteen minutes reduced to about 350° for the remainder of the time was satisfactory as these ovens hold more heat. With cottage loaves, the time should be increased to about 60 minutes, depending upon the size of the loaves and the number in the oven.

Cooling and Storing Bread. After the loaves are baked, they should be removed from the pan at once and placed on a wire rack to cool. Too rapid cooling in a draft may cause cracking of the crust. However, loaves should never be covered with a heavy cloth. Bread should be stored in a clean bread box when cold.

Staling of Bread. The ability of a loaf to retain its freshness over a period of several days is an important quality of home-made bread. The use of milk and an increased amount of shortening aids in this as also does the maintenance of a relatively low dough temperature during mixing and fermentation. High baking temperatures also aid because lower oven temperatures require a longer time, consequently the loaf dries out during baking. Rapid cooling and storing in a tin bread box are advisable. Baking bread at least twice a week is necessary in order to have it of desirable freshness. The baker supplies the market with fresh bread daily and reduces the price approximately fifty per cent to dispose of day-old bread, so great is the consumer’s preference for the fresh loaf. Research seems to show that fresh bread is as digestible and nutritious as stale bread and vice versa (5).
FERMENTATIVE VALUES OF YEASTS IN VARIOUS FORMS AND FOR DIFFERENT PERIODS OF STORAGE

Methods of Testing. The fermentative values of yeasts in forms commonly used by the homemaker were investigated. Most of the bread consumed in the rural areas of Wyoming must necessarily be made in the home and from yeast that can be stored for several weeks. Fresh compressed yeast or baker’s bread cannot be delivered each day or week to the ranch home as is the case in rural districts in more thickly populated states.

In the tests of the activity of various yeasts, the flour was a constant. An 80 per cent white flour milled from 70 per cent of Marquis spring and 30 per cent of Turkey Red winter wheat was used.

The fermentative values of the dry yeast cakes were tested in both starters and sponges with combinations of the two. The basic ferment per pound loaf consisted of 3 grams or \( \frac{1}{4} \) cake of dried yeast, 15 grams or about \( \frac{1}{2} \) of a small potato, \( \frac{1}{2} \) cup of potato water, and 4 grams or 1 teaspoon of sugar. This formula was varied to include the water in which hops had been cooked, also by omitting the potato and increasing the sugar. Sponges differed from the liquid yeasts in that flour was added. Both were incubated at 70 to 75° F. for about sixteen hours before mixing into a dough to which was added fat, salt, sugar, and flour. The dough was fermented at 80 to 85° F. in proofing cabinets. The time in the dough was determined by the lightness or bulk which was measured in fermentation tubes graduated in cubic centimeters.

Mashed potatoes and potato water speeded the fermentation and lessened the time forty to sixty minutes. An excess darkened the loaf. The water in which dried hops had been cooked seemed to have favorable effects on controlling the enzymatic action in the liquid yeasts. Too much slowed up the fermentation. The starter could be stored for longer periods without deterioration when some hops liquor was added to it. Sponges were preferred to starters with the strong Wyoming flours and were usually as speedy in their action with the same amounts of yeast.
Stiffer doughs lightened less readily than slacker doughs. The texture was best with doughs of medium stiffness.

Age of Yeast and Bread Quality. In the course of these tests it was frequently noted that results were less constant with older yeast. This led to an investigation of the age of dried yeast in relation to bread quality. Dried yeast cakes secured fresh from the factory were stored and tested in bread after varying intervals. The packaged yeast was placed in glass Mason fruit jars which were air tight or practically so. Some of the jars containing the yeast were stored in a cabinet at room temperature, others were kept in the refrigerator, and the remainder, in a cool, damp cellar. There was little evident deterioration after several weeks in any of the lots, but there was a loss of approximately forty per cent in strength after six months storage at room temperature. This lot was practically worthless after nine to ten months. The yeast which was stored in the refrigerator in an air tight container retained its activity over longer periods. Storage in a cool basement gave results very similar to refrigerator storage.

The yeast manufacturers try systematically to keep only fresh stock on the retailer’s shelves, but the time it is kept in the home before it is used is beyond their control. The dating of yeasts, as with other foods which deteriorate upon storage, is a practice which would be of great aid to the home baker. It has recently been adopted for Maca dry granulated yeast.

Many Wyoming housewives have welcomed this new dry granulated yeast which is now on the market. No preliminary ferment or sponge is needed and the entire bread-making process is completed in five to six hours. The three storage methods outlined above for the dry cakes were tested with this yeast. As with the cakes, its activity lessened with storage but was retained for longer periods when kept in a cold dry place. It has long been known that cold temperatures are necessary to keep compressed yeast in good condition. It seems advisable to adopt this method for storing dry yeasts that are to be kept for some time.
Breads made from a sponge and a liquid yeast with the dry cakes and from Maca, the quick acting dry yeast, are shown in Figure 1.

**Freezing Compressed Yeast and Effect on Bread.** Compressed yeast was frozen in the freezing tray of the refrigerator at a temperature of 19°F. Surprisingly, it maintained its activity over a period of several months. Dough became light in a normal time, and the resulting bread was of a good volume and quality as can be noted on the cover illustration. Compressed yeast was also frozen in a specially constructed refrigerator in which brine was used to maintain the low temperature of -16°F. The cakes were stored at this temperature for five weeks. They were restored to normal functioning by thawing in lukewarm water and mixing in a dough according to the standard bread formula. The dough became light in the usual period of time,
and the resulting bread was of an excellent quality. The fermentative values of compressed yeasts frozen and unfrozen were also measured by the Sanstedt Blish pressure meter, which records in millimeters the gas liberated. The results confirmed those secured with the expansion tubes.

Why this form of plant life survives such low temperatures over a period of time is not known. High temperatures have the opposite effect upon yeast.

The freezing method for the preservation of compressed yeast might well be adopted by the rural homemaker when some distance from fresh sources of supplies. Where refrigerators are not available in all ranch homes, other methods of keeping compressed yeast frozen throughout the cold winter months are feasible in this state where there is much snow and ice. Storing the frozen yeast in an air-tight and moisture-proof container is advisable. Unfrozen compressed yeast purchased at the market and stored at 40 to 50° F. remained in good physical condition with a normal gas production for only a few days.

Frozen liquid yeast or starters were less desirable than compressed. They retained their activity for a few days but after a week or more did not leaven the loaf sufficiently for baking.

SOME COMMON DEFECTS IN BREAD AND THEIR CAUSES

Sour Bread. In attempts to determine causes for sour flavors in home-made bread, tests of the total acidity of the liquid yeasts were made. The acid was expressed in cubic centimeters of N/28 NaOH required to neutralize 10 cc. of ferment, according to the method of Blish and Hughes (7).

The basic ferment after 16 hours at 70° F. required about 6.78 cc. of N/28 NaOH to neutralize 10 cc. of ferment, but after four days the amount of acid in the starter was trebled. Larger amounts of sugar increased the acidity, whereas the addition of the liquid in which hops had been cooked decreased it. Starters kept in a refrigerator over a period of several weeks showed only slight increases in acidity. An everlasting starter, which reputedly had been in use for 31 years, had a high acid content. The pH values confirmed these results. Dough made from the
starters high in acid were slow in rising. It is known that the enzyme zymase, which brings about the fermentation of glucose to alcohol and carbon dioxide in the dough, does not act in a strongly acid solution. There may also have been fewer yeast cells and the development of other substances in the old ferments. The resulting bread was poor in quality and flavor.

If bread is baked twice in a week and the starter stored at cold temperatures (40 to 50° F.) in the intervals between bakings, there should be no trouble with sourness. If the bread is not baked as often as this, the starter should be renewed by making up a new mixture at least once or twice a week, if the weather is hot.

Sour flavors may also develop if the fermentation of the dough has not been stopped at the right point by punching and folding, or if the dough has fermented at temperatures that are too warm.

Ropy Bread. The home baker is occasionally troubled with ropy bread during the hot summer months. This condition is readily recognized, since the crumb in the center of the loaf becomes sticky and discolored. It is usually accompanied by a disagreeable odor and nauseating taste. Ropiness is caused by a microorganism belonging to the group known as *bacillus mesentericus* which occurs naturally in the soil and is most frequently present in the outer parts of vegetables and grain (6). The organism may find its way into flour and may also be carried by the potato to ferments.

A simple remedy is to use fresh yeast and increase the acidity of the bread. This may be done either by adding white vinegar in amounts of about one-half teaspoon to each cup of water or the whey of sour milk as a part of the liquid. This bacillus may live for some time in crevices of the flour bin, which should be cleansed thoroughly at frequent intervals and exposed to sunshine. The organism thrives with dampness, warmth, the accumulation of dirt, and poor ventilation (6).

Other Defects. Other defects in the home-made loaf are often evident. It is difficult for the housewife to secure as con-
sistent results as the commercial baker, since very little stand-
ardized bread-making equipment is available in homes to control
humidity and fermentation temperatures. Fortunately a good
grade of hard wheat flour can withstand quite a variable range
in temperatures, and fermentation and still produce bread of a
fair quality.

A dark color and gummy compact texture have perhaps been
the most common defects in home-baked bread noted by exten-
sion nutritionists. These may result from old starters or poor
flour. In many cases such defects are no doubt due to lack of
skill in the bread-making process such as too high temperatures
for fermentation or too low baking temperatures. These have
been discussed in more detail elsewhere in this bulletin.

Proper baking temperatures should be gauged by thermom-
eters or heat regulators. The new kitchen ranges are quite gen-
erally equipped with reliable heat regulators which control temp-
erature automatically. If not so equipped, a mercury portable
oven thermometer, which can be set in the oven, is also reliable
and can usually be obtained through local hardware dealers for
about $1.50.

There is a correct oven temperature for baking each type
of food, depending in a large measure upon its composition. The
temperatures listed in reliable baking charts will insure a higher
quality of all baked products, if they are used.
PRACTICAL APPLICATION
WHITE YEAST BREADS

The formula and method of handling the dough varied with the process and the type of yeast.

A. Straight Dough Method, Short Process

Bread may be made according to the straight dough method with compressed or Maca yeast. The fermentation is comparatively speedy with these yeasts and may be completed in five to six hours. If the time must be shortened, more yeast may be added. The texture is impaired with too much yeast. Flour is a variable factor, and the amount of liquid needed varies with the water absorbing capacity of the particular flour used. The proportion which is usually satisfactory is 1 cup of liquid to 3 cups of flour.

1. White Bread with Compressed Yeast.
   (Makes 2 loaves)
   
   1 cake compressed yeast  
   1 7/8 to 2 cups water or milk  
   2 tsp. salt  
   5 tsp. sugar  
   4 tsp. fat  
   6 cups flour

Mixing and Baking Procedure. Measure salt, sugar, and fat and place in a bowl. Add scalding liquid, cool to lukewarm. Dissolve the yeast in a small amount of lukewarm water (85 to 90° F.) and add with the flour to the above mixture. Mix in the mechanical mixer at low speed for ten minutes. If a mechanical mixer is not available, knead with the hands, folding the dough over from the outside toward the operator, then pushing it away with the palms of the hands and continue this kneading for about 15 to 20 minutes, adding a little flour from time to time if the dough seems sticky. Knead until the dough has become smooth and silky on the outside and no longer sticks to the board. All the flour necessary should be worked in at this time.

First Rising. Place dough in a greased bowl or kettle. Cover closely. Let rise at a temperature of 83 to 85° F. If a constant temperature is difficult to maintain, the bowl of dough
may be placed in a pan of lukewarm water (90 to 93°F.). Allow the dough to treble its bulk. Punch down by folding from the sides to the center, turn over, and return to the proofing cabinet for a second rising.

Second Rising. Cover the dough and allow to rise at 80 to 85°F. until it has doubled its bulk, which usually requires slightly over one hour.

Molding Loaves. Turn dough onto a molding board. Divide in two even portions. Round each into a ball. Cover closely and let rest on the board 20 minutes. Flatten each piece into a sheet, fold from either side to center. Stretch dough lengthwise, fold ends to center, letting them overlap and seal. Then shape with hands in a roll and place in a pan, smooth side up. Do not add flour at this time, since it may cause the loaves to have a dark colored crumb and a coarse harsh texture.

Rising of Loaves. Place in a proofing cabinet or in a warm place away from drafts. The loaves should rise until doubled in bulk or about 1½ hours.

Baking. The oven temperature should be around 415°F. for gas, electric, or oil ovens. The more loaves, the greater the initial heat required. After ten minutes the heat may be reduced to 375°F. for the remainder of the baking. Somewhat lower temperatures are advisable with coal or wood ranges.

Variation with Frozen Yeast. Compressed yeast, frozen for periods ranging from a few days to several months, may be used in the same amount and manner as the fresh yeast. Precautions must be taken that the frozen cakes are thawed in barely lukewarm water so that the yeast is not killed. This method is recommended because the yeast becomes sticky and mushy when thawed in the package and hence difficult to handle. The time for fermentation is approximately the same as for the fresh unfrozen yeast.
2. White Bread with Maca Yeast (13).

(Makes 2 loaves)

\[
\begin{align*}
\frac{1}{2} \text{ package Maca} & \quad 2 \text{ tsp. salt} \\
\frac{1}{3} \text{ cup lukewarm water} & \quad \frac{3}{4} \text{ cup milk} \\
2 \text{ tbsp. sugar} & \quad \frac{3}{4} \text{ cup water} \\
2 \text{ tbsp. shortening} & \quad 6 \text{ cups sifted flour}
\end{align*}
\]

Add the yeast and one-half teaspoon sugar to one-third cup of lukewarm water. Stir and let stand about five minutes. Measure the flour into the bowl. Make a "well" in the center of the flour. Add the softened yeast and the rest of the lukewarm liquid into which has been dissolved the sugar and salt. Add the melted fat. Mix in the mechanical mixer at low speed for ten minutes or knead by hand twenty minutes. Use additional flour if necessary to make a moderately stiff dough. Place in a clean greased container, large enough to allow the dough to more than double in bulk. Cover closely while rising. For the remainder of the procedure follow the directions with compressed yeast.

B. Long Process with Sponge and Liquid Yeast.

This is the second of the two general methods for making bread. Dry yeast cakes are usually used which require a preliminary ferment or sponge in order that the yeast may become active. Bread with the sponge was preferred and usually rated somewhat higher in quality. These differences are shown in Figure 1.

2. White Bread with Double Sponge (13).

(Makes 3 loaves)

Thin Sponge at Night.

\[
\begin{align*}
\frac{3}{4} \text{ cake Yeast Foam} & \quad \frac{1}{3} \text{ cup mashed potatoes} \\
\frac{1}{2} \text{ cup lukewarm water} & \quad 1\frac{1}{4} \text{ cups sifted flour} \\
1 \text{ cup potato water} & \quad \quad
\end{align*}
\]

At night soak the yeast 20 minutes in one-half cup of lukewarm water. Mash the potatoes and add the potato water. When barely lukewarm, add the yeast and the flour. Beat well. Cover and let stand overnight in a moderately warm place (70° F.). Note: This may be prepared while getting the evening meal.
Thick Sponge in the Morning.

To the thin sponge prepared as above add:
- 2 cups milk or water scalded and cooled to lukewarm
- 4 teaspoons salt
- 3½ cups sifted flour

Early in the morning dissolve the salt in the lukewarm milk and add to the thin yeast mixture. Add enough flour to make a moderately thick batter. Let rise in a warm place (80 to 85°F.) until doubled in bulk. This will take approximately one and one-half to two hours.

Dough.

To the sponge when light add:
- 4 tablespoons sugar
- 4 tablespoons melted fat
- About 5½ cups sifted flour

When the sponge has doubled in bulk, add the sugar, fat, and enough flour to make a medium stiff dough. Knead by hand about 15 minutes or in the mechanical mixer ten minutes at low speed. Proceed with the rising, panning, and baking of the dough as in the recipe for compressed yeast.

3. White Bread with Liquid Yeast.

(Makes 2 loaves)

Starter:
- ½ cake Yeast Foam
- ⅛ cup lukewarm water
- ⅛ cup mashed potatoes
- ⅛ cup potato water
- 1 tbsp. sugar
- 2 tbsp. liquid in which dried hops have been cooked

Method of Mixing. Soak yeast in lukewarm water. Cook 2 tbsp. dried hops in ¾ cup water for five minutes. Strain liquid in which hops have been cooked through a fine seive. Add only the proportion indicated above as too much slows up fermentation. Keep the remainder in a bottle in a cool place for future use. Cool the potatoes and potato water to barely lukewarm, add with sugar to the soaked yeast. Add additional water to make one pint. Let stand in an open vessel in a moderately warm place (70°F.) about 24 hours. Put in a jar with
a tight lid and keep in a cool place (50 to 60° F.) until used. Hops may be purchased at any drug store.

Dough.

\[
\begin{align*}
\text{2 tbsp. sugar} & \quad 6 \text{ cups sifted flour} \\
\text{2 tbsp. melted fat} & \quad 2 \text{ cups of the above starter} \\
\text{2 tsp. salt} & 
\end{align*}
\]

Let the ferment stand in a warm room or in a pan of warm water until barely lukewarm (80 to 85° F.). Add the sugar, salt, and melted fat. Make a “well” in the center of the flour, pour in the liquid mixture. Stir in the flour and knead by hand 15 minutes or mix in the mechanical mixer at low speed about ten minutes.

Proceed with the rising, panning, and baking of the dough as in the recipe for the sponge bread.
PART II—WHOLE WHEAT YEAST BREADS

Whole wheat bread offers a welcome variation in the diet. In the past few years, with the spread of education in nutrition, there has been a decided increase in the consumption of whole wheat breads in cities and small towns. Such an increase has not extended to the rural communities where bread is usually baked in the home. Recent surveys in several states have shown that whole grain breads are rarely baked by the housewife. In an eastern state these breads were used in only one-sixth of the rural households where 57 per cent of the bread was baked in the home (8). Extension nutritionists have made similar observations in Wyoming. The reasons given by the homemaker were that it was much more difficult to secure good bread from whole wheat flour, the bread was not as well liked by the family, and whole wheat flours became infested with insects after a short storage period.

Very little experimental work seems to have been done with the home baking of whole wheat breads. Tests at the Wyoming Station have shown that modifications from standard white bread formulas are necessary, since the baking strength of whole wheat flour is considerably less than that of white flour.

Granulations of Whole Wheat Flour. Four different granulations of whole wheat flour were used in the experiments which are the basis of this report. (1) The fine was made so it would pass through gauge No. 30 standard mesh wire, (2) the medium through No. 18, and (3) the coarse through No. 10. (4) The very coarse was classified as unsifted cracked wheat. The weight varied with the granulation, the fine flour weighed 152 grams per cup, the medium 147, the coarse 141, the very coarse 117, and the white flour 112. The fine whole wheat flours were sifted once before measuring but still had a higher average weight than is usually listed for this flour. Bread can be made entirely from whole wheat flour that is very finely granulated but it is rather solid and not very pleasing in texture as is shown in Figure 2. The American people prefer a lighter textured loaf; therefore, certain proportions of white flour were used in developing a
palatable and light loaf. The proportions varied with each of
the granulations. The coarser the granulation of whole wheat
flour, the more white flour needed. With a very fine granula-
tion in which the wheat was ground so that it would pass through
gauge No. 30 standard mesh wire, around 45 per cent of whole
wheat flour gave good results; with medium granulation, 40 per
cent; and with the coarse flour, 35 per cent. Bread from the
finest granulation of whole wheat flour was preferred. The
volumetric measure of whole wheat flour, particularly for the
finest granulations in the bread recipes, was considerably less
than white flour, due in part to the difference in the weights of
the white and whole wheat flours noted above.

Composition of Whole Wheat as Compared with White Flour.
Whole wheat flour contains, in addition to the endosperm from
which the white flour is made, some of the bran coats and germ
of the wheat. Both the whole wheat and white flour listed below were manufactured from an equal blend of Turkey Red hard winter and Marquis hard spring wheat. The following analyses were given by the manufacturer:

<table>
<thead>
<tr>
<th></th>
<th>White Flour</th>
<th>Fine Whole Wheat</th>
<th>Medium Whole Wheat</th>
<th>Coarse Whole Wheat</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture</td>
<td>13.80</td>
<td>10.80</td>
<td>12.80</td>
<td>14.30</td>
</tr>
<tr>
<td>Ash</td>
<td>.39</td>
<td>1.61</td>
<td>1.80</td>
<td>1.63</td>
</tr>
<tr>
<td>Protein</td>
<td>11.70</td>
<td>13.60</td>
<td>12.70</td>
<td>13.00</td>
</tr>
</tbody>
</table>

A comparison shows that the white flour has considerably less ash and somewhat less protein than the whole wheat. The moisture did not show a consistent variation.

The ash of the whole wheat flour is particularly rich in phosphorus and iron. Studies of children's dietaries make it quite evident that no very economical diet for a child can be liberally supplied with iron without the use of cereal foods, including whole wheat breadstuffs. The availability of the iron in fine whole wheat flour for haemoglobin formation has been determined and was found to be utilized very well. Investigations further reveal that whole wheat bread containing a considerable amount of wheat germ is a good source of vitamin B, or thiamin, which can be further increased by using high vitamin yeast.

**Storage of Whole Wheat Flour.** Many housewives have difficulty in storing whole wheat flour. The bran coat and germ portion of the wheat which is present probably cause more ready infestation with insects than is the case with white flour. There are many insects that become troublesome in flour mills. A few of the more common are the Mediterranean flour moth, weevils, and flour beetles. The ordinary destructive insects that infest grain or flour lay eggs so large they cannot pass through the meshes of No. 10 XX silk bolting cloth. White or bolted flour is therefore, less liable to show infestation. It is possible, however, for mills to produce both white and whole wheat flour that is entirely free from infestation. If whole wheat flour contains no insect eggs, it will keep almost indefinitely at room temperature.
Several lots of this flour of the granulations previously described were stored in tight tin containers for a period of ten to twelve months at room temperature with no infestation. Other lots showed infestation after two to six months. The tin containers were in a laboratory where the temperature averaged 70 to 80° F., and the humidity was very low. Tight tin containers were found the most satisfactory method for storage of all flours in the semi-arid climate of Laramie.

Variations in Ingredients and Effects on Flavor and Quality. Varying the proportions of whole wheat flour and white flour in the formula had more effect upon the flavor of the bread than any other variation in ingredients. The next greatest effect was produced by varying the kinds and amounts of sweetening. Molasses, honey, brown and white sugar, and combinations of these were used. Molasses in comparatively large amounts gave a distinctive flavor but retarded fermentation, and the loaves had less volume than the others. It was most desirable in combination with white sugar for sweetening. Brown sugar gave an excellent flavor to the whole wheat bread in the proportion of two to three tablespoons per pound loaf. Honey in small amounts had little evident effect upon the time of fermentation or the flavor. A distinctive honey flavor could not be distinguished in the bread when honey was used in the proportion of 51 grams or about two tablespoons for each pound loaf.

Salt in the proportion of 8 grams or $\frac{3}{4}$ teaspoons per pound loaf was preferred for flavor, or slightly more than was used in white bread.

There seemed little difference in the quality of the bread when the fat was varied from two to four teaspoons per pound loaf.

Mashed potatoes and potato water speeded the fermentation in the long process, but the texture was more desirable when only a comparatively small proportion of potatoes were used. Slightly larger amounts of liquid were needed than with the white bread since the bran increases water absorption.

Good whole wheat bread can be secured by using yeast in the various forms that have been described in Part I of this bulletin.
Fermentation and Handling of Dough. Dough in which there was a considerable amount of whole wheat flour cannot stand as much expansion as dough made from white flour. Both the white and whole wheat flour were manufactured from hard wheat, consequently the whole wheat dough tolerated the same number of fermentations, but the expansion was less each time than for the white dough. The expansion for whole wheat dough averaged 1450 cubic centimeters or about one and one-fourth times the original bulk for the first fermentation period. The dough was allowed to double its bulk for the second fermentation and also in the pan.

A slightly stiffer dough and less whole wheat flour was used with Maca, as with this yeast, the whole wheat flour dough was more apt to fall which occurred during pan proofing as well as in the oven.

A baking temperature of 400 to 410°F. for ten minutes, which was then reduced to 375°F. for 30 minutes proved satisfactory for one-pound loaves in individual tins. The length of time for baking was increased to 60 minutes when six to eight loaves were baked in dripping pans in the same oven. The more loaves baked at the same time, the higher the initial temperature needed and the more time required to produce a loaf which was satisfactorily baked.

SCORING FOR PALATABILITY

The judging was done by trained home economists. Their ratings were supplemented from time to time by those of home economics students and other individuals. Those who worked with the product day after day proved to be the best judges of quality.

In making comparative ratings three or more samples of the bread were compared with a standard loaf.

The following weight of the various factors were used in scoring on the basis of 100 points for a perfect loaf:
The judges were asked to specify the loaves they preferred. The taste preferences of homemakers who commonly baked their bread seemed to depend in some measure upon flavors to which they were accustomed.

**PRACTICAL APPLICATION**

**Whole Wheat Yeast Bread**

Both the short and long process have produced good whole wheat bread using the technique and methods described. The total time was lessened considerably with either Maca or compressed yeast. The proportion of whole wheat to white flour favored by the judges varied with individual preferences. The amounts used in the following recipes have given a light, palatable loaf which was preferred by the majority of the judges.

**A. Short Process or Straight Dough Whole Wheat Bread**

1. **Whole Wheat Bread with Compressed Yeast.**

   (Makes 2 loaves)

   1 cake compressed yeast
   
   \( \frac{3}{4} \) cup lukewarm water
   
   \( \frac{1}{4} \) cup brown sugar
   
   2 tbsp. fat
   
   2\( \frac{1}{2} \) cups whole wheat flour
   
   3\( \frac{1}{2} \) cups white flour
   
   3 tsp. salt
   
   1\( \frac{1}{2} \) cups liquid (use \( \frac{1}{2} \) milk and \( \frac{1}{2} \) water)
Soak yeast in three-fourths cup lukewarm water, scald the remaining liquid, pour over the salt, sugar, and fat. Cool until barely lukewarm. Add the yeast mixture and the flours which have been well blended. Knead by hand 20 minutes, as with the white bread, or in the mechanical mixer at low speed for ten minutes. Let rise in a covered container at 80 to 85° F. until one and one-fourth times its bulk. Punch down, fold from side to center, and turn over. Let rise a second time until double in bulk. Punch down and fold again. Make into loaves. Pan and let rise at 85 to 90° F. until double in bulk or until an indentation remains in the dough when pressed with the finger. Bake at 400° for ten minutes and 375° for an additional 30 minutes.

Variations in Sweetening.

(a). Molasses in the proportion of 2 tbsp. with 1 tbsp. white sugar per pound loaf may be used.

(b). Honey and brown sugar in the proportion of 1½ tbsp. each per pound loaf gave a good flavor.

2. Whole Wheat Bread with Maca Yeast.

(Makes 2 loaves)

½ pkg. Maca yeast
½ cup lukewarm water
2 tbsp. fat
5 tbsp. brown sugar
3 tsp. salt
2 cups whole wheat flour
3½ cups white flour
1½ cups liquid (use ½ milk and ½ water)

Soak yeast in one-half cup lukewarm water for ten minutes. Scald the remaining liquid and add salt, sugar, and fat. Let cool until barely lukewarm and add the yeast. Blend flours well and add to the yeast mixture. Knead as described in the previous recipe. The dough should be moderately stiff. For fermentation and baking, follow the procedure outlined in the recipe for compressed yeast.
B. Long Process or Starter and Sponge Bread

It is necessary that dry yeast cakes undergo a preliminary fermentation as with the long process white bread. Both sponges and liquid yeast produced good whole wheat bread.

1. Whole Wheat Bread—Sponge Method.

(Makes 2 loaves)

Sponge at Night

\[
\begin{align*}
\frac{1}{2} \text{ cake Yeast Foam} & \quad 3 \text{ tbsp. mashed potato} \\
\frac{1}{3} \text{ cup lukewarm water} & \quad 1 \frac{1}{2} \text{ cups white flour} \\
\text{1 cup potato water} & \quad
\end{align*}
\]

Dough Next Morning

\[
\begin{align*}
5 \text{ tbsp. brown sugar} & \quad 2 \frac{1}{2} \text{ cups white flour} \\
2 \frac{1}{2} \text{ tbsp. fat} & \quad 2 \frac{1}{2} \text{ cups whole wheat flour} \\
3 \text{ tsp. salt} & \quad \frac{1}{4} \text{ cup milk or water}
\end{align*}
\]

Preparation Sponge. In the evening, dissolve yeast in barely lukewarm water. Add the potato water, mashed potatoes, and flour. Beat until smooth. Cover closely and put in a moderately warm place (70°F) until the following morning.

Preparation Dough. The following morning when the sponge is light, add to it the lukewarm liquid into which have been dissolved the salt, sugar, and the melted shortening. Mix thoroughly with the sponge. Sift or mix the two flours together before adding the sponge. For mixing, fermentation, and baking, proceed as with the compressed yeast recipe.

3. Whole Wheat Bread with Liquid Yeast

(Makes 2 loaves)

Ferment

Use the same formula for liquid yeast as in the recipe for white bread.

Dough

\[
\begin{align*}
4 \text{ tbsp. brown sugar} & \\
3 \text{ tbsp. fat} & \\
3 \text{ tsp. salt} & \\
3 \text{ cups white flour} & \\
2 \text{ cups whole wheat flour} & \\
1 \frac{1}{2} \text{ to } 2 \text{ cups of the above liquid yeast}
\end{align*}
\]
Dissolve the sugar and salt in the ferment, add melted fat. Blend the two flours well, which may be done by sifting if a fine granulation of whole wheat flour is used. Make a “well” in the center of the flour and pour in the liquid mixture. Mix and knead by hand 20 minutes as with the other doughs or in a mechanical mixer at low speed for ten minutes. Proceed with the fermentation and baking as with the previous doughs.

**SUMMARY AND CONCLUSIONS**

1. Home-made bread of good quality depends in a large measure upon a high grade flour, active yeast, and skill in the bread making process.

2. Keeping the dough at moderate even temperature, handling the dough promptly to prevent over fermentation, and baking at correct temperatures are of prime importance in making home-made bread of high quality.

3. Wyoming hard wheat flour has excellent gluten properties and yields bread of good quality when fermented and baked under standard conditions.

4. Finely granulated whole wheat flour milled from hard wheat made better bread than the more coarsely granulated flours.

5. The coarser the granulation of whole wheat flour, the larger the proportion of white flour needed for a light loaf.

6. Whole wheat flour can be kept in good condition for a year or more if stored in tight tin containers at room temperature, providing there is no infestation in the flour when received from the mill.

7. Leavenings in common use in rural homes are variable factors in the quality of home-made bread. In these experiments, more consistent results were secured with quick acting yeasts than with the dry cakes in which preliminary sponges or ferments were used.

8. Both dry and compressed yeast stored in air-tight containers are active over much longer periods when stored at low temperatures than when stored at room temperatures.

9. Off flavors, dark color, slow fermentation, and heaviness in home-made bread resulted from over-fermented starters. There is no advantage in using the same line of starter from month to month or from year to year.

10. Compressed yeast kept frozen over a period of several months produced excellent bread which became light in a normal time.
ACKNOWLEDGMENTS

The author is indebted to Standard Brands and the Northwestern Yeast Company for fresh yeast to carry on the fermentation experiments, to Robert MacVicar for chemical determinations, and to Miss Hannah Wessling, Home Economist, of the Northwestern Yeast Company for suggestions on baking bread with dry yeast.

LITERATURE CITED