BREAD FACTS

WORTH READING
WORTH KNOWING
WORTH PRACTICING

PUBLISHED BY
RESEARCH PRODUCTS DEPARTMENT
WARD BAKING COMPANY

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PUBLISHED IN THE
INTEREST OF BETTER
BREAD MAKING
BY THE

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NEW YORK

INTRODUCTION

The American baking industry found itself during the war. The fundamental importance of bread as the main food, the lowest-price food, the food which contains more of the elements of nutrition needed in the daily diet of both young and old than any other single food of general consumption was proclaimed by government agencies in every country. With sufficient bread and milk the children were safe from hunger; were well fed. Bread became as it always has been, the main food of the soldier. With more bread during the war the people were better fed for both health and labor, than they are generally fed.

Consumers were taught the larger food value of bread during the war days. Business men from all ranks, called to help in the mobilization of the country's resources or in the equitable distribution and conservation of the food supplies, saw the facts as never before and with common consent placed bread in the front rank of national industrial importance. Food scientists, from government and state departments, from universities, large and small, and from private laboratories turned their first attention to bread and emphasized it as the one food to be protected and an adequate supply maintained. Housewives, through direct governmental, commercial and trade publications, were told about the food value of bread, about its dependability as the main food for the family—were brought to look at bread in a new, a larger and a more important food light—amounting to an advertising value that could not have been purchased at any price.

The economies of milling and baking were studied by both governmental commissions and by masters in the economics of practical business. From the standpoint of soundness, service and the absence of profiteering not another industry stood a better, a cleaner test. The economy and the better general quality of bread produced from the modern methods of the modern baker were compared by these same disinterested agencies, with the wastes, often baking failures and higher costs of most of the home baking—again to the credit of the baking industry.

Chemistry and physics, bacteriology and the other sciences as they apply to the growing of cereals, to the transportation and storage of grain against spoilage, to milling, to baking and to the accessory materials—yeast and yeast foods, milk and malt extracts, sugars, fats and salt—were put to work in these fields as never before. The pioneer scientific work formerly done by the few was at last acclaimed as a benefaction. Today, domestic science workers are seriously studying bread with more of direct interest in the work, the methods and product of the bakery. Milling companies and bakers are turning, with more dependence, to laboratory control as an aid to practical experience. Schools and colleges are giving the sciences, as applied to cereals and bread, more preeminence in their courses. Out of it all the American baking industry has established the American Institute of Baking as the cap sheaf for continuous, deep and thorough research, for the teaching of sound and practical facts about bread and baking, and for service to all who seek the aid of science in baking problems.

At no other time has the American housewife who does her own baking, or who does not put enough bread into the daily diet of her family been more receptive towards the good baker and good bread.

With all these facts before us we have conceived the idea of assembling for the baker some practical hints on better bread making, the food value of bread, applied science in the bakery and other important facts, all of which we have published in this little volume and which we hope may prove of some service to the trade in general and be a modest but valuable instrument in improving the value of the baker's loaf and help speed the coming of the day when the housewife will rely entirely on the baker for her daily supply of the "staff of life."

THE AMERICAN LOAF OF BREAD

The perfect loaf of bread has no written rules. Science may find and describe the whys but an artist makes the loaf. In no other industry are there so many variables. The flour, the yeast, the time and temperature, the proving and baking must all be fitted one into the other. In no other industry has the work of standardization been more difficult. A formula made out for one shop does not work in another, unless the variable factors have been stabilized towards one standard of ingredients and method. If the public could know the earnest care that goes into making a good loaf of bread they could not keep from universal appreciative response.

There are two points to clear up in the public mind about bread; one is volume and the other absorption. Volume, if not carried to the point of over proving, means lightness, digestibility and better bread. Bakers have competed among themselves for volume. This competition has been giving the public a slice of bread in which the starch and protein particles are better separated, one from the other, ready for the action of the human digestive processes. What is wanted in bread is that each and every particle shall be opened, opened to the fermentation actions which render it more wholesome, opened to the heat which renders it better baked. So the baker who studies expansion, works for expansion and gets expansion, without sacrifice of flavor —expansion with texture, even, finely divided texture, silky texture, with the bread still full of life, taste and wheat flavor—is doing as much for the human stomach as for his industry. Volume, with texture and flavor is the first standard, both for the baker and the consumer.

Another important point is absorption. Much bread is turned out of inferior quality because the yeast and its actions have not had enough moisture during the fermentation. It is easier to handle a dry loaf, than one more moist. Most doughs are too dry, and the resulting bread lacks in the eating qualities desired by the consumer. The yeast must have proper moisture, sufficient oxygen and proper food. Yeast foods are treated under a separate chapter. But it may be stated here that the perfect loaf must have, among other things, sufficient absorption and oxygen during the mixing and fermentation.

Proper mixing is another factor. The gluten is conserved and developed in the mixing, or injured, according to the perfection of the method. The high speed mixer produces a result which hand mixing cannot attain.

Time and temperature, the strength and quantity of the yeast, fitted into the time, temperature and the quality of the flour, systematic operation of the shop according to schedule, the proof, the temperature and condition of the heat and moisture in the oven, the humidity under which the doughs are raised, proofed and baked are, all, factors entering into the kind of loaf that the consumer again comes back for to the commercial baker.

Wheat flour is made into many products and combined with many materials—sugar, nuts, fruits, spices, eggs, icings and other ingredients to make it into a finished food; but the standard product from the bakery is the every day loaf, which the consumer will eat at each meal with other food and not tire of. The typical American loaf is developed from what may be termed the American home-made loaf. Its standards of excellence may be described as follows:

1. Full expansion with the top pulling, but not pulled loose from the sides.

2. Golden brown, or darker brown, depending upon oven steam, but in all cases showing that the sugars in the flour and added to the dough have not been used up through excessive fermentation. Perfect bloom is indicative of the sweet and better flavor. When this is absent the loaf has less flavor and less qualities which make it palatable.

3. When the loaf is cut open, fine, silky texture, with the dough cells finely divided, should accompany the full expansion. The fine division of the cell walls puts the bread in better condition for digestion and is characteristic of a properly conducted fermentation. The color of the crumb, or inside of the loaf, should be clear white, with life, due to both the finer division of the cell walls and to absence of detrimental fermentation effect upon the flour. The crumb should not crumble; that is, fall away in parts when it is cut, but should be

firm. The flavor should be the sweet and suggestive nutty flavor of wheat.

4. Such a loaf has good keeping qualities, and is palatable several days after baking.

The standard American loaf is baked in a pan, with a thin, rather than a thick crust as distinguished from the types of hearth breads where the amount of crust equals the amount of inside crumb. It is true that there is a large consumption of rolls and rye breads and breads of the Vienna or French type, but day in and day out the American public prefer the type of loaf which has been developed from the kind that "Mother" made and baked in a pan.

The state of civilization and the prosperity of a country can be judged by its bread. Everywhere, effort is made to leaven it so that it will be more digestible. In parts of Sweden the rye bread is baked at harvest and stored away. In other northern countries the bread is baked into thin cakes, on hot stones. The Persian makes a bread from rice and sour milk. In many of the Oriental countries sour milk and dough are set as the starter for the leavening of bread. This method is known in our South as salt rising bread. The leavening is a bacterial or biological action rather than a yeast or plant action.

But it is to the standard American loaf that the baker in this country can well turn for success, sticking to a few types, centering on quality in the few, rather than on large variety.

THE FOOD VALUE OF BREAD

Life is built up in steps; first from the soil, in the form of the plants; and then from the plant into the form of animal, and most animal life goes farther and feeds on other animals. Even in human nutrition the most economic way is to utilize, direct, larger quantities of grain, roots and plants for food. Take a bushel of wheat, for example: the human system converts over 90 per cent into nutritive value. But, if the bushel of wheat or other grain is used in the production of animal foods, the cow converts eighteen per cent into milk food; the pig fifteen and one-half per cent into pork food; poultry five and one-tenth per cent in the production of eggs, and four and two-tenths per cent in the production of dressed poultry; the lamb, three and two-tenths per cent, and no wool; the sheep two and six-tenths per cent, together with wool, while the steer turns only two and eight-tenths per cent of the grain into beef. So that if a nation has but a given quantity of grain foods with which to meet an abnormal demand, or if it has a high cost of living problem, the people are vitally concerned with that method of utilization which will furnish the maximum amount of nutrition for human consumption. In times of peace, as well as war, bread, with its proper balance with other needed food elements, constitutes the economic food answer.

The time has come when we have sufficient of dependable knowledge about foods, about the nutritive value of bread, about the daily food needs, *to go to the public with definite statements of the amount of bread that should, for health, strength, proper nourishment and proper economy, be put into the daily diet.* In this direction of definite advertising lies not only opportunity for increased sales but for service to the public. How much bread should the child, the growing boy and girl, the man or woman at work with muscle or with mind eat each day? With what food combinations can bread be made the most appetizing to the taste and most nourishing? How does bread best combine with fruits and vegetables, with jams and jellies, with soups and meats, with eggs and puddings, with butter and other fats, with syrups and honey? What does it need to supplement its vitamines and mineral salts? A study of such facts leads to but one conclusion: that each individual should eat from a pound to a pound and a half of bread per day, to be well and economically fed, and that the public can be convinced of this fact if the baker will come to know and proclaim the full food facts.

The daily need in food elements are in order of quantity:

Carbohydrates
Fats
Proteins
Mineral salts
Vitamines

The authorities in nutrition agree that the average adult should eat daily:

Carbohydrates	500	Grams
Protein	100	"
Fats	50	"
Salt (Sodium Chloride)	10	"
Other Mineral Salts	9.85	"

Vitamines (quantities not determined).

One pound of bread furnishes:

Carbohydrates	240	Grams
Protein	40.5	"
Fats	12.1	"
Salt (Sodium Chloride)	6.7	"
Other mineral salts	2.78	"

The daily mineral salt needs are stated to be:

Salt (Sodium Chloride)	10	Grams
Potash	4.37	"
Phosphates	3.25	"
Sulphur	1.2	"
Lime	1.0	"
Magnesia	.02	"
Iron	.01	"

Iodine, Fluorline, Bromine
and other minerals—small quantities

One pound of white bread furnishes in mineral salts:

Salt (Sodium Chloride)	6.7	Grams
Sulphur	1.08	"
Phosphates	.98	"
Potash	.43	"
Lime	.14	"
Magnesia	.14	"
Bromine	.008	"
Iron	.004	"
Other minerals		traces

Now bread furnishes the frame work of the daily food need. And what the consumer wants to know is just how to build onto the frame work; just what other foods to add to make the diet complete. The facts, free facts, facts with the weight of undoubted authority, facts gleaned through years of patient and world-wide study and experiment, are waiting now for the baker to fit them to his bread.

Bread is not only a valuable and economic source of carbohydrates but wheat bread is also the source of the best cereal proteins. Wheat bread is then both a carbohydrate and protein food, together with valuable quantities of phosphates, potash, sulphur and the sodium and chlorine added from the salt used in bread making. White bread furnishes the more digestible form of these carbohydrates and proteins. Yeast bread, properly mixed, properly fermented and properly baked furnishes these food elements in still more digestible form. This is the reason why yeast bread is the preferred form of bread in all lands where wheat and rye are available—wheat and rye because of their gluten content which distinguish them from other cereals. The yeast not only raises the bread but its enzymes act on both the starch and the protein, rendering these food elements more digestible and more available for human nutrition.

As pointed out, carbohydrates are the chief daily need in human nutrition. Bread furnishes the cheapest, yeast bread the most digestible, form of cereal carbohydrates; *and in depending on bread for the energy-giving carbohydrates, consumers can also obtain half of their required protein supply.*

Hunt and Atwater in Farmers' Bulletin 824 of the United States Department of Agriculture have summarized the needs in nutrition, especially from the standpoint of sufficient protein, with reference to bread as follows:

"Since the protein foods include many of the more expensive foods in common use, and since an adequate supply of protein is essential to the growth and upkeep of the body, it is especially important for the housekeeper to know how much her family needs and to be able to choose the materials which, in her particular circumstances, will best provide the proper kind and amount."

"The foods usually classed as rich in protein are: milk and cheese; eggs; meat, poultry and fish; dried legumes, such as peas, beans, cowpeas, soy beans, and peanuts; and almond and some other nuts. Wheat, oats, and some other cereals also furnish considerable amounts of protein. Milk is the best source of protein for children. There is about one-fourth ounce of protein in each of the following: One glass of milk, one egg, 1 1-2 to 2 ounces of meat, 1 ounce of cheese, and 13 ounces of bread. A man at moderate muscular work is believed to need about 3 1-2 ounces of protein a day, and a family consisting of father, mother and three small children about twelve ounces a day."

"*It is possible to plan an attractive and wholesome diet in which one-half of the necessary protein is supplied by bread and other cereal foods which are relatively cheap.*"

In discussing the relative food values, the true approach is to know just what food elements are necessary in building up and running the human machine, and allow each product to present itself, on its merits, for its proper place in the building. It is from such approach that yeast-wheat bread, measured by all other foods in its class, ranks first in the food value of the food elements which it supplies. Nor is there need for controversy over whole wheat bread versus white bread. The whole wheat has more of the mineral salts and more fiber. The baker bakes both kinds of bread; but as a standard for the daily diet, the consumer prefers and demands the white bread. The consumer can, at will, select the whole wheat bread.

There have been many reasons for the separation of the wheat berry in milling. The germ of the wheat spoils; the bran of the wheat does not yield its nutriment to human digestion as readily as do the inside portions of the berry. Though backed by the earnest and disinterested propaganda of food writers, though advertised at extensive expense by baking firms the demand for whole wheat bread is limited. All can agree that the germ is rich in protein and fat, and the bran rich in some of the mineral salts needed in human nutrition. And here lies opportunity for scientific developments in the form of grain extracts which will still further separate the valuable elements of the wheat offal from the fiber. The human machine needs fiber but the human taste seems to prefer the more succulent fiber from green vegetables and ripe fruits. Differing rations are needed for differing needs. The large milk and butter records among dairy cows have been made on rations containing substantial quantities of wheat bran; while the mule at the plow is given a bran ration but once each week;and the thoroughbred that breaks records under the saddle or at the sulky has the bran mash at still less intervals. Let there be no quarrel with the miller or the baker because the consumer demandsbread frompeeledwheat.

Even whole grains do not contain all of the elements recognized as necessary in the human diet. They are deficient among other things in lime. Dr. H. C. Sherman of Columbia University says after summarizing a list of valuable data about human nutrition:

Journal of Industrial and Engineering Chemistry, Vol. 10, No. 5, Page 383.

"It cannot be denied that the rapid progress of our knowledge of nutrition during the past few years has tended to complicate rather than simplify our conception of food values and nutritive requirements. But, while the problem has become more complex, it also has become clearer because we now for the first time have good reason to believe that all of the substances needed for normal nutrition have been recognized and can be reckoned with even though the chemical identification is in some cases not yet complete."

"The efficiency with which economy in the use of food and the conservation of the food supply can be combined with entire adequacy of nutrition is chiefly dependent upon the adequate diet in quantitative terms."

"These results indicate very strongly that the average American dietary contains a much more liberal margin of protein than of either phosphorous or calcium, and that while the danger of a protein deficiency is rarely serious the danger of a deficiency of phosphorus or calcium is more important. Phosphorus deficiencies are plainly more frequent than are deficiencies of protein, and calcium deficiencies are more frequent still. The old assumption that adequate protein may be taken as meaning adequate supplies of all tissue-building material is found to be wholly misleading. Adequate energy intake is, in practice, more apt to insure adequacy of mineral elements, but even if all of the 246 dietaries had been brought to a basis of 3,000 calories per man per day, 12 per cent of them would still have furnished less than the average 'requirements' of calcium."

Also to Drs. Mendel and Osborne of Yale, to Dr. Lusk of Cornell, to Dr. Forbes of Ohio State, and to Dr. McCullum of Johns Hopkins, who have done so much pioneer work on the substances popularly called "vitamines" and mineral salts and to others of their class we turn today for accurate knowledge of proper foods and proper feeding. Dr. McCullum has worked with long patience to find out just what cereals need to make them into complete foods. In addition to the vitamine need in nutrition, he points out the need for the addition of mineral salts to cereal foods as follows:

"The growth records make possible the generalization that it is difficult, if not impossible, to obtain even a moderate amount of growth over an extended period on a diet restricted to the seeds of plants. It is evident that satisfactory protein mixtures can be had from seed mixtures, and from the results it is further evident that certain seeds as flaxseed and millet seed contain the fat-soluble A in fairly liberal amounts. Since the water-soluble B is everywhere abundant in the seeds the cause of failure to secure growth on seed mixtures is seen to lie in the amount and character of the inorganic moiety. An inspection of the literature relating to the content of inorganic elements in various classes of natural foods as determined in recent times by satisfactory methods reveals at a glance the supplementary relationships among the different classes of vegetable foods in inorganic elements. Of the seven most important seeds from the standpoint of human nutrition and animal production, only cottonseed and flaxseed contain a high total inorganic content and in both cases the ash is very poor in three important elements, sodium, calcium, and chlorine. *Since a pronounced deficiency of these elements is characteristic of all other seeds as well, no combinations of seeds will supply these elements in satisfactory amounts. Since spring and well waters in certain districts contain both sodium and calcium in greatly varying amounts it would be expected that animals may secure the necessary inorganic supplements through the drinking water in some localities which would enable them* *to grow on a ration restricted to seeds, whereas in other parts of the world they could not do so.*"—Journal Biological Chemistry, Vol. 30, page 13.

We sell in wheat bread a food containing refined carbohydrates and the best form of cereal protein, with these food elements rendered more soluble and more digestible through the action of the yeast. In addition, bread contains substantial amounts of needed mineral salts. No claims at present are made for vitamines; but in studying the relation of the food elements and the mineral salts contained in bread to the daily amounts needed in human nutrition it is plain that with milk, grain extracts, and additions of mineral salts, bread can be brought more and more towards the standards of a complete food. In selling bread, welcome the dairyman, the vegetable and fruit grower, the meat packer, the fisherman, and poultryman, and then say to the consumer, with full warrant of nutritional authority: "Make half of your daily diet bread, and this means at least a pound of bread for each individual per day. And with this pound of bread as your food basis then add such other foods as will give the full complement of vitamines, mineral salts, fats, other proteins and carbohydrates, as your purse, your taste, and a correct knowledge of food values aids you to determine."

HINTS FOR BETTER BREAD

There are many troubles encountered in the baking of bread. In making suggestions it is quite difficult, at times, to diagnose a trouble, but hints will often suggest a remedy to follow. The baking foreman when encountering trouble with his doughs and bread should pause a moment, reflect and check himself to see that the proper procedure was followed in making up the dough. By analyzing the situation, the trouble will often solve itself.

The Rising of the Dough

You may notice that the dough is not rising properly. A thermometer will tell you whether you set the dough at the proper temperature. Too much salt will retard the rising. If you permit the yeast to come in contact with the salt for only a fraction of a minute, before mixing the dough, there will be a decided falling off in the strength of the yeast. Dissolving the yeast in very cold water will check the rising. Examine the yeast to see if it is fresh. You may have gotten hold of some stale yeast. Fresh compressed yeast should have a good smell, not putrefactive, the color should be creamy yellow, and not dark, and it should break with a clear fracture and not show the consistency of butter. You may have left your yeast standing in a warm place. A warm temperature, even for a short time, is detrimental to yeast action. Know how long yeast has been in the refrigerator. Yeast deteriorates from the instant that it is put into compressed form. This deterioration is all the more rapid the warmer it is kept and the longer it is kept.

You may observe that your dough rises rapidly at first, but it gradually loses its activity, the dough rises slowly in the pan, and the dough, instead of having a "kick" in the oven, refuses to expand properly. This may be caused by the nature of the yeast. The yeast may have a strong initial fermentation but it loses its strength before the bread is baked. If you have not supplied the yeast with sufficient fermentable material in the form of sugars, the action will become weaker and weaker. Warm temperatures will also cause a rapid start but the final action will be slow and sluggish. The best kind of fermentation is one which starts slowly and increases in vigor and reaches its best activity when the dough is in the pan. This condition is attained when there is proper nourishment for the yeast in the dough.

Arkady Yeast Food supplies an ideal food for the yeast in the dough. It causes the yeast to grow and produce new yeast which, by its very nature of growth, has a maximum raising power. Starting with less yeast when using Arkady, you naturally get a much slower action in the first period, but after the first punch, which is in about two hours, you begin to get the effects of the newly produced yeast and the dough begins to rise more vigorously and continues so until your bread is baked.

Be sure your yeast is fresh and feed it properly to insure good results.

Proper Fermentation Period

By fermentation period is understood the time required to properly develop the dough. This is the time interval from the time the dough is mixed until it is ready for scaling.

There is no laboratory test which will determine this accurately, although the tests are admirable guides. A high speed mixer develops the gluten, so a shorter fermenting period is required, than when using a slow speed. The longer a dough can be mixed with a high speed mixer, the better the dough will be developed and the shorter will be the fermentation period. Some flours, however, will not stand vigorous mixing so an understanding of your flours is necessary. Flours with a strong, tough gluten will stand more mixing than flours of the soft winter wheat type.

A dough which has had too much mixing will be sticky when it comes from the mixer. It will remain sticky during the time it stands in the trough; it will scale with difficulty; it will proof poorly, tending to run flat in the pan and it will not expand properly in the oven. Northwestern flour, as a rule, requires more time in the dough than the Southwestern flours. Among the Southwestern flours, Kansas, Oklahoma and Texas flours require a little more time than the Nebraska and Missouri flours. The Kansas and Missouri flours require more time than the flours from California, Oregon, Washington, Illinois, Indiana, Kentucky, Ohio, Pennsylvania and the Eastern states; and the latter flours more time than the very soft wheats of Michigan and Wisconsin. The Canadian flours probably have the toughest and largest amount of gluten, of any flours. They can stand lots of mixing, and must have a long time to develop the gluten most effectively. The doughs from these flours may be soft when they come from the mixer. They have the power, however, to become tough again as the fermentation progresses.

There are seasons, however, when the above remarks will not hold for a given territory. The larger portion of the wheat crop for Montana, in 1918, produced a flour much like the Canadian flours. The gluten was tough but elastic, and it was present in large amounts. This flour required a long fermentation to get the best results. However, the 1919 wheat crop of the same state produced a flour which was deficient in gluten, as well as one that was weak and did not stand much fermentation. The 1918, Northwestern and Southwestern wheats, gave a flour with a strong gluten and plenty of it; so a 4½ to 5 hour fermentation gave excellent bread. The 1919 crop from the same localities gave a flour which showed its best results when taken in 3½ to 4 hours. The 1920 wheat crop promises to give an excellent flour for gluten quality and gluten strength. A longer period of fermentation with a slacker dough will give better results than you are getting with the 1919 crop, using the shorter period of fermentation.

There are a number of factors which will influence the fermentation period. In the first place, the amount of yeast that is used, the quality of the yeast, and the age of the yeast, will affect the time. The stronger the fermentation, naturally, the shorter the time required to develop the dough. Warm temperatures shorten the period, through increasing the activity of the yeast and through stimulating those ferments which act best at higher temperatures and which are always present in a dough. These act upon the gluten, making it soft and elastic. Some of this is to be desired, but when this action goes too far the capacity of the dough for holding gas and then giving the proper "kick" in the oven is gone. The weaker the flour the more noticeable will be this action.

Salt tends to lengthen the fermentation period. It checks the ferments which act on the gluten and checks the yeast action, and it toughens the gluten. Whole milk, skimmed milk, powdered milk, sweetened condensed and unsweetened condensed milk lengthen the time. They have a binding effect on the gluten. Buttermilk, on the other hand, shortens the time, due to the acidity and the ferments which the buttermilk contains. Cane sugar, glucose, corn sugar and maltose sugars seem to have little direct effect upon the development of the dough. They ferment about equally well in the dough and other than supplying fermentable material for the yeast they do not effect the fermentation period. Malt extracts, however, shorten the period of fermentation. The higher the Lintner value the greater will be the action on the dough. Shortenings also shorten the fermentation period a little. The better they are incorporated in the dough, the greater will be their action on the dough.

Naturally, a strong yeast or one that has been supplied with the proper food for the yeast will develop the dough quicker, and make the fermentation period shorter than a dough made from a weak yeast, or one not supplied with yeast food.

Arkady Yeast Food decreases the time of fermentation by 30% when the average quantity of yeast is used, but by cutting the quantity of yeast from 40% to 50% the fermentation period of the dough will remain the same as when no yeast food is used.

Is a short fermentation period desirable? It is, if the dough can be developed most effectively in a short time. Flours which are weak should be developed rapidly, and for these the shorter periods are desirable and necessary. A flour with a strong tough gluten will give best results with a longer period of fermentation. For flours with a large amount of tough gluten, a moderate amount of yeast with a long time will give a better result than a large amount of yeast and a short time, and for weaker flours with a small amount of gluten and one that is soft the reverse is true. More yeast and less time are preferable.

It is a difficult matter to say and still more difficult to determine just exactly what is the correct fermentation period of a dough. After you have the analysis of the flour to show you the quantity of gluten and the quality of the gluten you get an idea of how much fermentation the dough will stand. You will get an idea of how much yeast and how much salt to use, and the time required to develop the gluten properly. The best procedure to follow is to make a dough of proper consistency with the quantity of yeast and salt that you think it should have. Set the dough at 80° F. and scale one fourth of the dough after it has stood 3½ hours and work up in regular way. Take another ¼ of the dough after it has stood ½ hour longer making four hours from time dough was mixed, and proceed as with first portion; take the third quarter after it has had 4½ hours; and the last portion after it has had 5 hours. If this is not convenient for your shop then make separate doughs with same formula and temperature but give the dough different times, one dough 3½, one 4, one 4½, and one 5 hours. Make accurate observation and keep notes on what you observe in regard to the dough; its scaling; its moulding; the proving and the quality of bread produced. After the bread is cold *inspect* and determine which of these periods of fermentation gave the best bread. You may find that all of the bread baked is below your standard of quality. The loaves may all have a tendency to be flat, in particular those that had the most fermentation. You should then try using more yeast, but cut the time to three hours—three and a half and four hours and see which give best results. Or, you may find that the dough with five hours gave the best results in that run, but bread still inclined to be too small. It may be you are using too much salt for this flour, and it is preventing the dough from expanding in the oven. Try using less salt and giving the dough five hours or use a little more yeast and still give the dough five hours' fermentation.

If a piece of dough is taken from a batch each half hour, for six hours, from the time of mixing, scaled, rounded up, moulded into a loaf and baked in usual way, it will be found that one of these loaves will be better for appearance, size, texture and color of crumb, and flavor over all the others. The one which is best in these points has had very nearly the proper fermentation period. All the other loaves will have had either too much or too little fermentation. It is true some will be nearly as good as the best one, but even an inexpert person can tell the difference. The dough is developed gradually from the time it is mixed until it reaches a maximum development and after that stage is passed the dough loses in quality; it becomes undeveloped again, so to speak.

The time required for the maximum development of the dough cannot be ascertained accurately but we can come very near to it by making a series of bakes as described above. Fortunately there is a fairly wide range of time through which we can ferment a dough and still produce a salable loaf of bread. There is one correct period of fermentation for every dough, when the highest quality loaf of bread is produced, the loaf that creates and holds a customer.

Is it then possible for a baker to make several kinds of bread, all of the highest quality from one dough; some of it getting three hours of fermentation and the other possibly six hours? The answer is, he cannot. One piece of his dough will probably make a good loaf, whereas the remainder of his goods will be either made from a dough which is too young or one that comes from a dough with too much age.

Many a baker will probably say to this, "Well, my trade likes my bread and I follow this practice." His business is small, because he follows this practice, and if it is not his competition is small. The remedy for this is to set separate doughs, for each type of bread, instead of setting one dough for a variety of products. It may involve a little more time, but it is the only way to produce the highest quality products. At times, the baker sets one dough large enough to fill two ovens, but he only has one oven in his shop. He takes one half of the dough forty-five minutes before the other half. The result is he has bread of two different qualities. Far better results would be obtained by setting two doughs, each just large enough to fill the oven, and no more.

The highest quality flour, yeast, shortening, sugar, malt, milk, salt, etc., will not insure the baker good bread if his dough is not fermented properly. For that reason such importance is placed upon the necessity of determining proper fermentation period of the dough. In fact, it is the very key to the production of a quality loaf.

Sticky Doughs

It is the experience of every baker to encounter sticky doughs. A warm temperature may be the cause. Gluten acts very much like glue; the warmer it gets, the stickier it gets. A sticky dough will result if the yeast weakens during the rising of the dough. Malt extracts with high diastatic and proteolytic enzymes if used in too large amounts will make the dough soft. A knowledge of your malt extract and the judicious use of it with different flours will save you many troubles. A young dough will feel sticky and will even be sticky and have a tendency to run when in the proof box. Some flours, especially when made from damaged wheat, due to rains, show a remarkable stickiness when made into dough and the longer the dough stands the more this develops. One way to handle a flour of this nature is to use lots of salt and yeast, and use a short fermentation period. The better solution is to get rid of the flour, if possible to do so. Mixing the dough so long that the gluten loses its elasticity causes a condition of stickiness. This applies to the high speed mixers. There is no danger of making a dough sticky with a slow speed mixer.

Young and Old Doughs

A young dough, as the name implies, refers to a dough which is not developed properly. The loaf of bread baked from such a dough will have a dark reddish brown crust, and quite frequently there will be blisters, just beneath the crust. The loaf will be small and flat, showing little oven spring and if there is any spring the loaf will have a poor appearance. A young dough will take on color quite readily in the oven. In the proof box the dough will flatten out in the pan, and will, in most cases, take considerable time to proof. The dough will also be quite sticky in the pan during proofing, and will also look as though it were sweating. Young doughs have a strong tendency to stick to the divider and moulding machine. If the dough is quite young the texture of the crumb will be coarse and the color will be quite yellow, but the flavor will be good.

Old doughs show some characteristics of young doughs, in that the doughs stick quite badly when scaled and when it passes through the moulding machine. The odor of an old dough is strong, suggesting a sour yeasty smell. An old dough does not show the same stickiness and tendency to run in the proof box that a young dough does, and when it goes to the oven the dough may first show a little expansion, standing up round, but when the loaf is baked it will be smaller than when the dough went into the oven. The gluten in an old dough tends to pull together in the oven. This is often referred to as having a binding effect. The dough will color slowly in the oven and the crust will be pale. The bread will have a coarse texture and the color of crumb will be dark, but it will not be yellow like that of a young dough; it will have a dirty gray color. An old dough is easily recognized by the strong sour smell of the baked bread. The loaf also crumbles when cut and tastes very poorly. Many bakers ferment their doughs too much. It is much more desirable to take the doughs just on the young side than a little old. You gain in flavor, in keeping qualities and in the bloom of the crust. Bread from an old dough dries out quickly and gets stale very readily. Remedies for old doughs: set dough cooler, or shorten fermentation period, use more salt or use less yeast.

Proving the Dough

Proof, as we commonly understand the term, is applied to the rising of the dough in the pan, if it is pan bread, or if hearth bread the rising period from the moulding of the loaf until it goes to the oven. Broadly speaking, proving also includes the rising period from the time the dough is scaled until it is moulded into the loaf.

This first period of proving though important is not so vital as the second stage, when the loaf is moulded. This first period should require about 10 to 15 minutes under ordinary conditions. However, if the dough is warm and the room is hot, as is often the case, this period should be less. With cold dough the time may be longer. The dough, after being scaled and rounded up, should receive a certain amount of recovery, before moulding. Poor moulding due to improper proof may result from an under, as well as an over proved dough. Under proving will tend to make the loaf heavy and may even cause blisters in the bread. Over proving should be avoided. It develops a skin on the outside which will cause streaks in the bread and it will mold with difficulty; the dough will tend to tear and stick to the machine and will not mold smoothly.

The second stage of proving is an important step in the production of a good loaf. A good flour, or a good yeast, is often condemned because of failure in proving the dough properly. The proof room should be kept at 95 to 100°F. and the atmosphere almost saturated with moisture for pan breads. Under these conditions the loaf should proof in 45 to 60 minutes. A dough taking longer than one hour to proof may be slow, due to insufficient yeast; it may have too much salt; the yeast may be weak, due to exhaustion, or the dough may be cold, due to setting the dough cold or getting the dough chilled after scaling. A long time in the proof box should be avoided as the gluten loses its ability to hold gas over a long period, especially, as it is matured. The dough will show a tendency to flatten in the pan and the resulting bread will lack the oven "kick." The bread will have a poor texture and the color of crumb and the general appearance of the loaf will not be good. See that you are getting a quick proof. However, avoid taking your doughs under proof as this will make your doughs stand up round and will pull away from the pans when in the oven. The bread will be heavy; it will not bake well in the oven;

it will lack in bloom and the odor and flavor will be strong. Caution—do not over proof the dough. A dough which has had too much proof will not show much oven "kick;" the texture of the bread may be even, but it will be coarse, the color of the crumb will be off, and the crumb will show a great tendency to crumble when cut. Do not try to get volume in your loaf by proving. A properly proved loaf if it is fermented properly will show a lively spring in the oven and will give you the proper size. The bread should show a small break with shredded appearance on the side of the loaf. Too much heat is injurious in proving; the dough will flatten and the resulting loaf of bread will, naturally, be flat, and may have numerous blisters beneath the crust; the texture will be coarse and color of crumb dark.

A proof box that supplies warmth and moisture is essential for every shop; regardless of whether you bake one dozen loaves or one thousand.

The dough should be kept warm and moist during proving.

Controlling the Temperature of the Dough Room

A loaf of bread of uniform goodness can only be obtained where shop conditions are controlled.

The two vital ingredients, flour and yeast, are very susceptible to changes of temperature, particularly when in the dough. Cold temperatures check the activity of the yeast. At 60°F. fermentation practically ceases; at 70° there is slow action of the yeast but from this point the yeast activity increases until a temperature of 95 to 100°F. is reached, when it begins to fall.

Experiments have shown that a dough fermented at 77° F. produces 25% more gas than one set at 68° F. At 86° 34% more gas is produced than at 77° F. At 95° F. 15% more gas is produced than at 86° F. A strong yeast action is desirable in the dough but the strong action obtained through warm doughs, though desirable, must be avoided. A warm dough is undesirable for many reasons. As a rule, the colder dough increases absorption. Low temperatures, however, check the yeast. Doughs set lower than 78° F. work slowly.

Unless you are using the sponge process or a long time dough avoid setting doughs colder than 78° F., even though your absorption is increased, at the lower temperatures.

Warm temperatures make your doughs runny and sticky, they become difficult to handle in the machines and the longer they ferment the worse they get. Warm doughs also stimulate and multiply undesirable bacteria. These will cause your dough to have objectionable flavors, odors and a poor bloom. Rope will develop best under these conditions.

The best and most practical results will be obtained when doughs are set at 79° to 81° F. The dough should increase in temperature so it will be about 83° to 84° F. when ready for scaling. A most excellent loaf of bread can be obtained at lower temperatures but this necessitates more yeast, more time and a greater expense in making. So temperatures lower than 78° F. are not frequently employed, except when sponge doughs are made. Sponge doughs are frequently set as low as 75° F. during the warm weather. The temperature of the dough room should be 80° F.

Baking the Loaf

No specified time or temperature can be given at which a loaf of bread should be baked. The weight of the loaf, the character of the bread, the age of the dough, the ingredients used and the proof of the loaf all must be taken into consideration when attempting to give the proper temperature for baking. A good heat for pan bread is 450° to 500° F. At this temperature the loaf should bake in 35 to 45 minutes, depending upon the weight of dough in the pan. It is quite necessary that your thermometer register the temperatures accurately. Many thermometers are not accurate and the position of the thermometer in the oven may give you the wrong temperature.

A dough which proves slowly and one which is young should be baked in a cooler oven. This will give the loaf an opportunity to expand and it will prevent it from coloring too rapidly. Old doughs need higher temperatures to give color to the crust. A cold oven makes a larger loaf than a hot oven but the keeping quality and flavor of the loaf is not so good. The degree of fermentation of the loaf determines, in a measure, the time required to bake a loaf. If you have a quick fermentation it will bake more quickly than a slowly fermented dough.

A properly baked loaf will have a crumb that is springy and will come back quite readily when pressed with the finger. An underbaked loaf will feel doughy and will show an impression when pressed. A good test also is to press the loaf quite flat when it is baked and note whether it recovers again. If the loaf remains flat it is not baked enough. Good bread can be made either with or without steam in the oven. The character of the crust and bloom will be different. A loaf baked without steam will not have the golden brown color and glossy appearance that a steamed loaf has. The crust of the loaf, however, will be short and quite tender. Steaming the dough makes a tougher crust and puts a gloss on the loaf. Care must be exercised where using steam. It should be used only during the early part of the baking. Too much steam will check the expansion of the dough and it will interfere with the opening up of a cut loaf. Good wet steam should be used and of just sufficient pressure to supply the necessary moisture.

There are two types of heat "solid" and "flash" heat. A properly constructed oven with thick walls and made of the proper materials will produce a continuous heat and will not fall off much during the baking. This is known as "solid" heat. The heat is radiated slowly and continuously from the walls to the loaf. This insures a thorough baking of the loaf and also gives it the proper bloom. A "Flash" heat is a heat which is only temporary, but frequently intense for a moment and then falls off rapidly. Some ovens will only produce a "flash" heat. Their walls are thin and so must be heated very high before putting in the bread. The result is that the oven first burns the bread and toward the end is so cool that it does not completely bake the batch. Obviously the oven with a solid heat is the preferable one.

Handling the Baked Loaf

The loaf when it is baked should be placed on clean sanitary racks or conveyors in a clean, cool, sanitary place, and cooled as rapidly as possible. The quicker the loaf can be cooled the longer the loaf will keep. Quick cooling prevents the loaf from loosing moisture and it protects it from undue exposure to germs that are everywhere in the air. It has been shown that in a crowded room 70,000 germs fall upon an area of 1 square foot every hour. The advisability for rapid cooling and then wrapping is apparent. A loaf of bread cooled in an atmosphere of cold dry air can be wrapped in 10 to 15 minutes after baking. Unless the bread is cooled in some manner it is not advisable to wrap it in less than 1 hour. Bread wrapped warm will be in a most favorable condition for developing rope during the warm weather.

If the bread is to be cooled quickly and wrapped it must have a good strong bake otherwise the loaf will be heavy and soggy. For an underbaked loaf more time is necessary so the loaf will dry out before wrapping.

Volume of the Loaf

We have shown the importance of a properly fermented dough in making quality bread.

The very purpose of fermentation is to make the loaf light, give volume to the bread. Every baker tries to make a well risen loaf. His aim is to get expansion. The volume of a quality loaf will necessarily vary because of the variance in the quality of flours and the variance which will be caused by the addition of different ingredients. It is an error to say that unless a loaf has a certain volume it will not possess quality. Flours vary in composition, some have a large amount of excellent gluten, some have a large amount of poor gluten, others have a small amount of excellent gluten, still others have a small amount of poor gluten. Blending these flours will change the amounts and expanding power of the gluten. All gluten, however, has a certain natural expansion when fermented; but this expansion varies in the different flours, and in the blends of flours. The flours with a large amount of excellent quality gluten will possess a high degree of expansion in the oven. These flours will, from the nature of the gluten make a loaf with a large volume. It would be folly to try to check the expansion and make the loaf smaller with flour of this nature. Either you would have an undeveloped dough or one that would be too old. Any process which could be used to hold the expansion in check would interfere with the natural function of the gluten and so would be detrimental to loaf quality. A flour of this nature must produce a large volumed loaf in order to give excellence of texture, of color, of flavor, of moisture retaining properties and in general appearance.

It would likewise be folly to try to make a large loaf with a flour low in gluten but with an excellent gluten. Any process used to increase the volume beyond a certain point will be injurious to loaf quality. A flour of this nature will produce quality bread, but the volume of the loaf will be small.

The point to be impressed here is that each type of flour will produce a certain volumed loaf possessing the marks of a quality loaf and it is up to the baker to determine just what he can get out of his flour. If his loaf is too large he should blend his flours so as to give him a smaller loaf. If too small, then he should get a flour with a gluten that will expand and give him the volume.

In order to produce the particular volume that is desired the baker must have a knowledge of the materials and conditions which effect the size of the loaf. A small volume does not necessarily imply that there is something wrong with the method of working. If the bloom of the crust is good, if the texture is good, the color good and the flavor good, you can feel assured that you are getting the best out of your flour and other ingredients. You may find your loaf heavy and soggy; however, if the color of crust is "foxy," your dough is young; if the crust is pale and odor of bread strong your dough is too old. Be sure your proof is correct, and be sure the dough is not injured during scaling and moulding. Under proving the loaf will give a heavy loaf, appearing as though it were gluten bound. Excessive proof will make a small flat loaf; too much heat in the proof box, during proving, will make the loaf small.

On the other hand, your volume may be satisfactory but the texture coarse, and the color inclined to be dark. This indicates that you are creating a volume by proving and the loaf may be larger than the quality of the flour justifies in producing; or, you may find that proper proving will give you a better expansion with the proper texture, color, flavor and bloom.

Character of the Crust and Crumb

The crust of the loaf should be of a golden brown color. It should be thin and tender. A tough crust is produced from strong, tough, glutenous flours when not given enough fermentation. Too much salt makes the crust tough as the salt has a binding effect on the gluten. An under-proved loaf will cause toughness. An excessive quantity of milk, too much steam in the oven, too much handling of the dough, after it is developed, and low grade flours produce bread with a tough crust. The crust of your bread may lack coherency; this indicates too much age, or too much proof. Weak flours have a tendency to produce such crusts due to being easily over-fermented. An old dough will give you a loaf with a pale crust, a cold oven may also be the fault. If you haven't sufficient sugar in the dough the crust will be pale. Sometimes the top crust is grey but the bottom of the loaf has a good bloom. This is caused by the dough getting too dry during proof, or the oven being too dry. You may find the bread too pale on the bottom, and top bloom satisfactory; more bottom and less top heat will give better results. If the loaf crumbles when cut the indications are that your dough is too old, or, you have given the dough too much proof. Weak flours will produce crumbly breads. Substitutes for flour also make the bread short and crumbly. A young dough will give the bread a yellow cast whereas, an old dough will give a dark grey color. Streaks in bread are caused by too much dusting flour at the moulding stage, or by the drying up of the dough in the proving stage before moulding.

A satisfactory development of the dough with proper richness of ingredients will give the perfect bloom to the crust and an ideal texture of the crumb.

Yeast

Within the yeast cells that come to you in compressed form, there lies a tremendous latent power ready to be released instantly the yeast is placed in proper surroundings. So great is this power that one pound of the yeast can raise one hundred and fifty times its weight of dough, from a small flat mass into a balloon-like mass five times its original size in a period of three hours.

This yeast has life. It is the very soul of the dough. Since it has life it is very delicate and needs attention and proper care to maintain its vigorous functions, producing gas and creating the juices which soften the gluten so as to give it perfect elasticity and make it easy for the dough to rise. Not only does it do that but it also grows new yeast, on the scanty food available for it in the dough. Yeast is a plant and so is very susceptible to changes of temperature. It grows rapidly. A yeast cell will reach full maturity in a few hours. It also dies rapidly. Yeast, as soon as it reaches maturity begins to weaken. This weakening is delayed by getting it into compressed form and keeping it cold, 40 to 45° F. The higher the temperature at which compressed yeast is kept and the longer it is kept the more rapidly it weakens.

The following tests made in the Ward Laboratory show how yeast loses strength when kept under different conditions. Gas collection test were made on a dough with the following formula.

Flour	100	grams
Water	61	"
Sugar	5	"
Yeast	1	"
Salt	1½	"

The doughs when set were 86° F. and the fermentation carried out in a chamber which was maintained at 85 to 87° F. during the entire test. On next page are given the quantities of gas produced from the above doughs, using yeast one day from the date of its arrival. One portion was kept in the refrigerator at 45° F. Another portion in the dough room, which was 80° F., and a third portion kept in the baking room where the temperature was around 95° F.

Cubic centimeters of gas produced in six hours:

Where stored	c.c. gas produced in 6 hours
Refrigerator 45° F.	1160c.c.
Dough room 80° F.	900
Baking room 95° F.	310

The above results show the vital necessity of proper refrigeration for the yeast. If the yeast comes to you in a warm condition, or, has been delayed in transit you can rest assured your yeast will work slowly. Examine your yeast on arrival and see that it is fresh. Yeast which has been kept warm, for even a short time, will show darkness on the surface and may even become soft and putty like. The yeast should break with a clear break and have a fresh yeasty smell. Stale yeast shows a putrefactive odor. When the yeast arrives, immediately place it in a refrigerator which should never be much higher than 45° F. Do not permit your yeast to stand around the dough room. Take just enough from the refrigerator to make the doughs you are setting at the time.

The following test shows how yeast deteriorates upon storage even when kept at 45° F.

Gas produced in six hours using previous formula:

Time stored after arrival	c.c. gas produced
1 day	1245 c.c.
2 days	1150
3 days	1120
8 days	850

Yeast stored at 80° F. deteriorates rapidly on storage as the tests below will show.

Time stored	c.c. gas produced
1 day	970 c.c.
2 days	750
3 days	555
4 days	365

Note the rapid falling off in the gas-producing power of the yeast when it is stored at high temperatures. Since the fermentation period of the dough depends upon the activity of the yeast it is quite obvious that, in order to have the fermentation period under control, the baker must have a yeast that works uniformly. He must get it fresh and he must keep it from losing strength.

Stamp the date on the package of the yeast when it reaches you. Use it as quickly as possible. Do not allow it to stay in storage longer then necessary.

These results on yeast tests show you the necessity for using yeast foods to bolster up your yeast in the dough whether you are a believer in them or not. *Get this fact.* Yeast which grows in the dough, has the greatest maximum of strength, greater than you can possibly get from yeast in compressed form. Grow yeast in your dough by using Arkady Yeast Food, now recognized everywhere, as the best source of food for yeast.

Salt

Salt, in addition to producing flavor, has a regulating influence upon the ferments in the flour and yeast. A good average quantity to use is three pounds per barrel of flour. Salt also has a strong binding action on the gluten. The more salt you use the more the fermentation required to develop the gluten perfectly. Some flours will carry more salt in the dough than others. Salt has a strong inhibiting action on the yeast. As you increase the salt you must likewise increase the quantity of yeast, in order to get the same rate of rising.

An average of many gas collection tests in the Ward Laboratory shows the following per cents of salt and yeast calculated on the flour, to give equal quantities of gas in the dough.

That is to say, 1% salt and .7% yeast will produce as much gas in six hours as 2% salt and 1.25% yeast will produce in the same time.

Salt	Yeast
1%	0.70%
1.25	.83
1.50	1.00
1.75	1.10
2.00	1.25
2.25	1.50
2.50	1.65
2.75	1.80

In selecting the quantity of salt you wish to use be sure and use the proper quantity of yeast to raise your dough.

Milk

Milk in any form is a very desirable ingredient to use in bread; if for no other reason than that of the food value which it possesses. It is the most nutritious and has the best proportions of food elements of any known food product. Bread made with milk will have a better flavor, a better bloom and will retain its freshness longer than a loaf made without milk.

Milk has a toughening action on the gluten so the more that is used the more fermentation the dough needs. The dough should also be set fairly slack so as to overcome the binding effect of the milk. Six pounds per barrel of condensed milk or two pounds of powdered milk are sufficient to make a good loaf of bread. Buttermilks work just the opposite to fresh milks. They mature the dough, due to the acidity and the ferments which they contain and so do not show a binding effect on the dough but tend to slacken it.

Shortening

The term "shortening" when used in bread making refers to fats and oils in various forms. These may be liquid, semi-solid or dry. The main purpose in adding these to the bread is to improve the texture and keeping qualities of the loaf. The crumb of the loaf also has better eating qualities because it is not so tough. Shortenings do not directly effect the fermentation. They do, however, aid in developing the gluten by giving it more elasticity, thus aiding its expanding power in the oven. Their action on the gluten also effects the texture of the loaf. The loaf texture is finer and closer and more silky than when no shortening is used.

The effectiveness of a shortening depends upon how well it is incorporated into the dough batch. Dry shortenings can be easily and thoroughly distributed in the dough and for this reason have greater shortening power in bread doughs than the liquid kind. Florolene in this respect leads all other shortenings. Another big advantage in using it, is its cleanliness.

Sugars

The bloom of the loaf, its flavor, the raising of the dough and the stiffness of the dough depend upon the nature and the amount of sugar used in the dough. Cane sugar, corn sugars, and maltose when used in equal dry weight raise the dough equally well, but they have different effects on the flavor and bloom of the loaf, as well as the color of crumb. Cane sugar excels in flavor, color and bloom, but present prices do not justify its use as the difference in quality over the bread produced by the other sugars is not sufficiently pronounced. Lactose or milk sugar is of no value in raising the dough, but it does help the bloom. The sugars slacken the dough. One pound of sugar displaces about ½ pound of water. The more sugar that is used—the less water you must use in making the dough. When more than 10 pounds of sugar per barrel of flour are used the raising of the dough is checked. Yeast works best when the sugar is kept below this amount. What has been said above also applies to such products as glucose, maltose, syrup, etc. Allowance must be made for the water they contain.

Malt extracts act somewhat differently than sugars. The most of them have 75 per cent solids but their diastatic and proteolytic properties vary, depending upon materials and methods used in manufacture. A good malt extract for bakers to use is one that shows about 60° Lintner. Some bakers prefer to use malt extracts that have no Lintner value. The higher the Lintner value of a malt extract the greater is its action on the gluten, so it is necessary to bear in mind the type of flour that you have when you specify the kind of malt extract that you want.

A safe quantity of malt extract to use in the average formula for straight doughs is from 2 to 3 pounds per barrel of flour. More or less can be used depending on the Lintner value, and the flour you are using. Malt extracts must be used carefully with weak flours.

The malt extracts and syrups are valuable aids in baking. A given weight of 60° Lintner extract will displace from 3 to 4 times its weight of sugar in the dough. The doughs, however, do not take nor carry the water, that doughs made from sugar do. Likewise the warmer your doughs are the stronger is the action of the malt extract on the gluten and starches of the flour. The yeast action is stimulated and the fermentation period shortened. However, with proper care, a loaf can be produced having an excellent bloom and flavor.

In general, sugars are necessary for the production of a good bloom on the loaf. The amount you should use depends upon the time you ferment the doughs, the temperature of the dough and the temperature of your oven. Sugars retain freshness in the loaf because the loaf readily takes on the desired bloom in the oven. A dough that has not sufficient sugar must be baked in a hot oven to give color to the crust or else baked a long time in a moderate oven both of which will drive too much moisture from the loaf.

WHEAT

June, July and August are the heavy harvest months for wheat. Seventy-five per cent. of the world crop is harvested in these months. But somewhere, in every month, wheat is being planted—is being harvested. Rice and rye, Indian corn and barley furnish the cereal supply for large numbers of world population. In the warmer climates the orientals grow and eat rice. In the colder north countries—Norway and Sweden, Finland and the northern sections of Germany, Russia and Poland—rye, oats and barley are the main dependence for cereal food. But even in these colder countries, as wheat, through the centuries, has been acclimated to the colder temperatures from the warmer regions of the Nile, it has been given first choice over all other cereals for bread making. Indian corn was the cereal food found on the American continent. The Aztecs cultivated corn on the high table lands of old Mexico. The American pioneers developed corn and made it their first cereal food. But they brought wheat; until today Great Britain, Belgium, Germany, the

Netherlands, France and Italy look with interest, at each harvest season, towards the hoped for three hundred million bushels of wheat surplus from the United States and Canada. And if Russia and the Balkans add another two hundred million bushels, if South America, India and Egypt give their normal wheat surplus then the congested centres of Europe may have their usual per capita of wheaten, leavened, more nourishing, more digestible bread.

The march of civilization, the development of the stronger types of thinking people have been associated with meat and dairy foods; but their development can also be associated with the growth or decline of wheat production. The Chinese have abundance of rice and poultry; but wheat was the cereal in their older and more powerful days. The new era of Japan is associated with the closer attention to wheat and the high average of twenty one bushels per acre produced by the Japanese farmer.

Even the strong dairy sections cluster around the lands of wheat surplus, and the wheat by-products are the first choice of all foods for the dairy cow.

The calendar of the world's wheat harvest shows how universal has this cereal become the first choice for human food. Wheat is harvested by months, and in the countries of the world, as follows:

January
- Australia
- Chile
- New Zealand

February and March
- Egypt (upper)
- India

April
- Asia Minor
- Cuba
- Cyprus
- Egypt (lower)
- India
- Mexico
- Persia
- Syria

May
- Algeria
- Asia (central)
- China
- Japan
- Morocco
- United States
  - Texas

June
- France (south.)
- Greece
- Italy
- Portugal
- Spain
- Turkey (Europ.)
- United States:
  - Alabama
  - Arkansas
  - California
  - Georgia
  - Illinois
  - Kansas
  - Kentucky
  - Mississippi
  - Missouri
  - No. Carolina
  - Oklahoma
  - Oregon
  - Tennessee
  - Utah
  - Virginia
  - Washington

July
- Austria-Hungary
- Bulgaria
- Canada:
  - Quebec

July (Cont.)
- England (south.)
- Germany
- Roumania
- Russia (south.)
- Switzerland
- United States:
  - Colorado
  - Illinois
  - Indiana
  - Iowa
  - Michigan
  - Minnesota (so)
  - Nebraska
  - New York
  - Ohio
  - Pennsylvania
  - Wisconsin

August
- Belgium
- Canada:
  - Alberta
  - Brit. Columbia
  - Manitoba
  - Ontario
  - Saskatchewan
- Denmark
- Great Britain
- Russia (central)

August (Cont.)	*Sept. and October*	*November*
Poland	Norway	Africa (southern)
The Netherlands	Russia (north.)	Argentine
United States:	Siberia	Peru
Minnesota (c'l and north.)	Scotland	
Montana	Sweden	*December*
New England		Burma
North Dakota		New South Wales
South Dakota		

The world per capita consumption of wheat is given by the United States Department of Agriculture, based on ten years average of production, import and export figures and seeding requirements as follows:

	Bus		Bus
Canada	9.5	Netherlands	4.2
Belgium	8.3	Roumania	4.0
France	7.9	Denmark	3.5
Spain	6.1	Chile	3.4
United Kingdom	6.0	Germany	3.2
Switzerland	6.0	Russia	2.7
Australia	5.5	Serbia	2.5
Italy	5.4	Sweden	2.5
United States	5.3	Egypt	2.5
Uruguay	5.3	Portugal	1.8
Argentina	5.2	British India	.8
Bulgaria	5.0	Mexico	.8
Austria Hungary	4.3	Japan	.5

The per capita consumption of wheat in the United States, by states, and the available supplies can well be studied by bakers. A baker in Alabama, Mississippi or Arkansas, with a wheat per capita consumption of four bushels has not the opportunity of the baker who serves Ohio, with a per capita consumption of 6 3-10 bushels; or Minnesota where it is 7 2-10 bushels; or Pennsylvania where it is 5 8-10 bushels.

Wheat is the main raw material upon which the baking industry depends and to know bread is to know wheat. Agricultural science has spent a long effort to increase production, improve varieties and increase the bread-making value of wheat. This effort can be helped and directed towards more definite bread-making results, through closer interest from the baking industry in the work of the agricultural scientist.

A century ago there were but few varieties, today agricultural science has developed a variety for all soils and all climates. Men like Luther Burbank foresaw that if one grain more could be added to each wheat head the result would add fifteen millions of bushels to the annual American wheat harvest. One reason for the superior food value of wheat is the amount and character of its protein content. Wheats vary in this ingredient from a minimum of eight to a maximum of twenty per cent. Colorada wheats are highest in protein; California and Carolina wheats yield more starch and less protein.

Why? The agricultural scientist is trying to find out, is making progress, and the baker is interested as this question affects the gluten strength of his flour and the food value of his bread.

In 1860 the average wheat yield per acre in the United States was around ten bushels; today it has passed sixteen bushels per acre; while in Great Britain and Germany the average yield per acre is around thirty bushels; in France the yield is past twenty bushels. Irrigation has added more than fifteen million bushels to the annual wheat harvest in the United States. The mineral needs of the wheat plant have been studied; just, as later, the mineral needs of the yeast plant were studied and determined. The wheat plant has been found to need phosphates, potash and nitrogen in the form of ammonium salts, or nitrogen gathered from the air by the pea and bean plants.

The making of flour begins in the wheat fields; if underripe the flour will make a sour and a dark bread; if well ripe it may lose in weight but the quality of the gluten is enhanced. The wheat undergoes changes in the shocks, in the stack, in the elevator, and the flour, after milling, is still subject to changes, the reasons for which are still not clearly worked out. It is in the ripening or aging—proper aging—of the wheat and flour that flavor, the delicious wheat flavor, is developed. In the process, too, the gluten quality is conserved or injured.

Milling is an art of its own. The main features of milling, after the proper wheat selections, are cleaning and tempering the wheat berry and separating it into the different classes or grades demanded by the baker and the general market. It is not generally known that the strongest gluten comes from nearest the bran. The more soluble proteins and starches are from the inside of the berry. But milling is another industry, at present, too distinctly separate to be combined with baking. While the progressive miller studies wheats from all sections and of all strengths, the baker must be equally free to pick for flour quality. In selecting flour the baker is interested in

the moisture content,
the quantity and quality of the gluten,
the flavor, and
the final way in which the flour bakes up.

The moisture of wheats vary, but American wheats are lower in moisture than European wheats. The moisture content of the average good flour furnished the American baker should be around thirteen per cent. Water is used in milling to temper the wheat, but it is possible to go beyond and increase the moisture content of the flour above that necessary to temper. Flour may lose moisture after milling and thus lose in weight. It is more apt to lose moisture than to gain moisture. A condition which causes it to gain moisture is not good for either its flavor or gluten quality. Flour is best stored in a dry temperature of from 75 to 80 degrees F. free from foreign odors. Excessive moisture or excessive heat injures gluten quality. The moisture test is one of the daily necessary tests in the scientific control of baking. If enough flour is used, the laboratory can pay its way by watching the moisture content of the flour. And when the moisture content and gluten strength are known the proper absorption and fermentation can be determined for the dough mix.

The quantity and quality of the gluten varies with wheat varieties, districts where grown, the condition of the season, the aging and protection of the wheat, the milling and the proper conditioning or aging of the flour.

Wheats that produce excellence in gluten content come from the northern middle and southern American states, of what may be called the American plains—from Minnesota, the Dakotas and Montana, south through Oklahoma, into Texas. Other lands where wheats of high gluten strength are produced are Canada, eastern and southern Russia, Roumania and southern Argentina. It is estimated that Canada, alone, has one hundred and fifty million acres capable of producing wheat of this class, not over seven per cent of which is now in cultivation. The entire wheat acreage in the United States for 1920 is given at fifty-three million acres.

Gluten does not exist in flour as such, but is formed from the glutenin, gliaden and other elements of the flour proteins. Chemists are studying the relation of the elements of gluten to gluten strength. This involves the chemistry of both proteins and enzymes—two of the most difficult, the most interesting fields in chemistry.

APPLIED SCIENCE AT THE BAKERY

The words "research," "applied science," "laboratory," and "chemist" have a far-away meaning to many in the baking industry. But the good superintendent of baking, though he may not know it, practices daily in the fields of chemistry, physics and other sciences. He knows the method which produces the results; in many cases he knows the underlying cause. But experiment and testing in the bake shop are costly, uncertain and inconvenient. Enough has been demonstrated to show the opportunities in adding scientific control to practical experience.

Any baker with his face set towards progress can make the start. Make a visit to the agricultural college. Pick a sophomore, a second year man, who has found himself and demonstrated his sticking qualities. Let it be a boy who stands well among his fellows, and who is, at least in part, earning his way through college. Talk the matter over with the dean of his course, and suggest that the boy take some studies related to cereals and fermentation, with his chemistry and bacteriology. When the summer months come, offer the boy work in the bake shop, in the actual operations connected with the dough. At the end of the summer he will return to college with a large part of your problem on his mind. Bring him back again during the summer before his senior year. When he graduates send him for a few months to the American Institute of Baking. Make him feel your personal interest in him; sell him heart and soul to the opportunity for clean work, for happy work, for public service as well as profit in the baking of good bread. Make him feel that this opportunity can be fully realized in your organization. Remember that his mind has been started to work during his college days and never forget this important point in dealing with him.

The next step is your laboratory. The plant ovens are the best for baking experimental doughs, and you will not need a laboratory oven. The balance of the equipment, for beginning, may be listed, at present prices, as follows:

General Equipment and Furniture

Proofing cabinet	$40.00
Yeast testing cabinet	25.00
Electric drying oven	115.00
Analytical balance	50.00
Muffle furnace	80.00
Moulding table for baking tests $25.00 to	50.00
Table for oven and muffle furnace	15.00
Table for analytical balance	15.00
Table for washing glutens	15.00
Sink and drain board with hot and cold water	100.00
Set weights for analytical balance—100 gms—5 mg—lacquered	12.00
Microscope $100.00 to	200.00
Plumbing and gas connections, not to exceed	200.00

Glass Ware and Small Accessories for Yeast Testing

4 Jars, Chidlow gas collection graduated to 1800cc. in 20cc. division accessory bottler, tubing and rubber stopper....$30.00

Glass Ware and Small Accessories for Washing Glutens

2—1 gal. capacity pottery bowls, white inside	1.50
6—porcelain cups	.50
1—spatula flexible steel with wooden handle 5" blade	.30
1—spatula steel non-flexible blade at both ends	.25
2—pipettes Mohr's graduated in 1-10cc	1.00
1—aluminum weighing scoop and counterpoise	3.35

Glass Ware and Accessories for Ash Test

6—Silica dishes	6.00
60mm.....diam.	
13mm.....deep	

Accessories for Baking Tests

6—mixing bowls with covers to be used for mixing and fermenting the dough	3.00

1—balance baker's scale with funnel scoop and counterpoise $15.00
1—set weights, brass in wood block 1gm.—to—1000gms.. 5.00
6—wide mouth glass jars pint size........ .60
necessary covered jars for holding sugar, salt, shortening, etc........ 2.00
1—500cc. glass graduated cylinder........ 1.25
1—100cc. glass graduated cylinder........ .75
1—bread knife for cutting bread and dough........ 1.00
1—large spatula, flexible blade........ 1.00

Accessories for Moisture Test

6—dishes, aluminum flat bottom with slip in lid........ 2.00
diameter........58mm
height........17mm

Miscellaneous Equipment, not to exceed........ 50.00

This laboratory equipped as above is designed for making the following tests:

On Flour	ash moisture absorption wet gluten dry gluten baking tests	*On Yeast*	gas production tests
		Tests on other baking materials	

The chemist has already learned to mix, mould, proof and bake a loaf of bread. Put him to studying how to produce a better loaf, from different flours and different ingredients. Put him to testing flours, the moisture content, gluten quantity and quality and how best to handle a particular flour in your shop. His skill will increase with the number and variety of flour samples tested and baked into loaves. From flour, his interest will expand towards oils, milk products, yeast, flavoring extracts and the long list of bakery supplies offered the bread and cake baker, soaps and cleaning powders, gasoline, lubricating oils. He will need more apparatus as he goes along, and as he shows you the particular need and usefulness to your business.

If he is the kind that will turn it to good account and not waste time, have him keep in touch with the local medical society, the high school chemist and domestic science teacher, the woman's club and other civic organizations. The opportunity to build up public confidence for your plant and your bread will be well worth the interest he takes.

In making tests of foods, the methods of the Association of Official Agricultural Chemists are reliable and at once available. He will need a small library to begin with, including a half dozen of the scientific journals. Have him start a systematic record plan of all tests and all experimental bakes; have him make sufficient tests and bakes to be sure of his facts. Suggest that he start loose leaf note books into which every item of interest relating to either the science or economics of baking will be brought together, making duplicate copies for your own use.

With your interest, backing and patience, his work will soon begin to show on the credit side of your costs sheets and in the increased quality and better uniformity of your bread. The rest will take care of itself. The methods worked out and used in the Ward Laboratories for testing flour are as follows:

"Weigh out carefully 10 gr. of flour in duplicate; place in a small dish or suitable receptacle; add 5 8-10 to 6 cc. of water to spring and hard wheat flours. If soft winter flour use 5½ cc. After adding the water to the flour make into a smooth dough by means of spatula. Be sure the dough is well collected into a smooth ball of dough. Cover dough with water at a temperature of 80° Fahrenheit. Allow hard winter and spring flours to stand one hour; soft winter flours, wash out glutens immediately after doughing up. The gluten is now ready for washing. 1½ to 2 liters of tap water—80° Fahrenheit are taken in a suitable bowl and the glutens are washed, taking a piece of dough in each hand. The dough should be washed very carefully in the beginning so as not to scatter the gluten. After gluten collects doughs can be washed more vigorously. In working be careful to collect any scattered gluten which may collect in bottom of bowl. Washing in the first water should take about ten minutes. This will get rid of the greater portion of the starch. The glutens are now removed and the water poured from the receptacle. Be careful to note whether any small pieces of gluten remain in the receptacle. If so, collect them with the piece of gluten obtained from the flour. A fresh sample of tap water is now taken, 80° Fahrenheit, and the final washing of the gluten made. This should take from twelve to fifteen minutes, the glutens being alternated every four or five minutes; that is, the gluten washed in the right hand for four or five minutes and vice versa. This change is necessary because the two hands do not work the dough equally and by changing from one hand to the other we find that we get more uniform results. When the gluten is completely washed it is dried between the fingers to a point where the gluten just begins to stick to the fingers. It is then placed on a piece of paper and weighed, using a tare piece of paper to balance piece holding the wet gluten. This weight multiplied by ten gives the per cent of wet gluten in the flour. The gluten is now baked in an oven at 150° C. from twenty to thirty minutes and then placed in a drying oven at 105°C. for at least twelve hours. The weight of dry gluten multiplied by ten gives the per cent of dry gluten in the flour. The ratio of wet to dry gluten can then be calculated. We find that by carefully washing the glutens the duplicate glutens should check within 1-10 of 1 per cent and not vary more than 2-10 of 1 per cent. We also find that different manipulators get uniform results when using this method. It is a significant fact that the higher the ratio, wet to dry gluten for a given flour, that is, for a spring or a hard winter flour, the better the baking quality. A good spring flour should have a ratio of three to one; the hard winter, 3.1 to 3.2 to 1; soft winter flours which are washed immediately after doughing, the ratio of wet to dry is 3 to 1. The ratio of wet to dry gluten for a given type of flour depends upon the grade of flour. The lower the grade the lower the ratio of wet to dry gluten."

ARKADY

Arkady is a yeast food. The word stands for the initials of Robert Kennedy Duncan, first director of the Mellon Institute at Pittsburgh. To the hundreds of American bakers daily using Arkady, it means better bread and increased bread sales. The baker who learns Arkady, learns what it is to make a better loaf. It brings standardization into his shop and a better control over the dough batch. It saves yeast, for it feeds yeast. It saves flour and sugar from fermentation loss, for it helps the yeast do its work on the living, budding growing side, instead of on the destruction side of fermentation. The combination of mineral salts in Arkady was put together, after long and patient experiment, for the central purpose of standardizing the waters used in baking. The result did the job, standardized the waters, made up the deficiencies in mineral salts needed for a healthful fermentation in the dough, and produced the better loaf of bread. But in a trial in baking, it was found that the average amount of yeast generally used had to be decreased. Further use and continued study proved that Arkady cut the fermentation losses one half. Visualize a hundred barrels of flour. Four of them are burned up into leavening gas, in the dough process. Two of these barrels are saved from the loss through the use of Arkady. Visualize a hundred barrels of sugar for bread making. From thirty to fifty of them will be used up by the yeast in the fermentation trough. Arkady saves at least fifteen of them from waste; saves them into the loaf to give more bloom, more flavor, more food value; or saves them to the other sugar needs, in times of sugar shortage.

Arkady has shown what science can do for baking. Robert Kennedy Duncan was a professor in the University of Kansas. He saw what science was doing for the dairyman, the farmer, the wheat grower. He followed on with his idea. Why should not science extend its investigations to the whole field of human effort? What about the food products after they reached the factory for preparation for the consumer? What about the helpfulness of science in these fields? Why do foods spoil? How could the spoilage be prevented? What about the laundryman? What about the relation of chemistry to the soil on clothes and removal without weakening the fiber of the garment? And so he joined his ideas with the big human interest and money of the Mellons at Pittsburgh. And the Ward Baking Company was one of the first industries to seek the help of the Institute.

Mr. George S. Ward, President of the Ward Baking Company, stated in 1917 the early history of the development of Arkady as follows:

"About six years ago, in an effort to standardize our product, our company, operating in different cities and having a natural desire to have our bread equal in one city to what it was in another, endeavored to standardize it, and in doing that we found some difficulties in our fermentation problems which we could not understand. Upon closer study we discovered that the hardness of water, or the softness of water, as the case might be, affected the fermentation. In other words, notwithstanding the fact that we had laboratory control of the raw material—the raw material coming from exactly the same sources, the flour from the same mills—in spite of that, we were not able to make the same bread in Boston as we did in the city of New York, or the city of Pittsburgh, or the city of Cleveland, and we finally hit upon the fact that it was because of the difference in the water.

"About that time in Pittsburgh a public spirited man named Mellon opened up the Mellon Institute for Industrial Research. I took this problem to him and to Dr. Duncan, Director of the Institute, and our company established fellowships to undertake research in bread making. The water problem was taken up at once by Dr. Duncan and his staff, and they soon found that the mineral salts in the water had an influence on the action of the yeast in bread making. They set to work to try out varying amounts and different combinations of mineral salts as generally found in water, in experimental baking. When the combination of mineral salts as now used in Arkady was reached they baked up loaves of bread with and without these salts, and each time the loaf made with Arkady was selected by us as the better loaf.

"We then asked about the wholesomeness of the process, and the Mellon Institute replied that it was entirely wholesome. We went further, and submitted Arkady to medical experts of high standing. In each case they reported not only that it was wholesome but added to the food value of the bread. The conservation and yeast-saving facts reported from the Mellon Institute were submitted to and confirmed by a large number of chemists connected with some of the best known universities, colleges, and research laboratories. All of our facts have been submitted to the Federal and State pure food officials. The Ward Baking Company, has made the fullest effort in its own investigations to establish the truth, the full truth, and we have been equally interested in throwing all of these facts on top of the table, so that all who may be interested in the scientific progress of the baking industry—bakers, pure food officials, legislators, press and public—may study for themselves what has been accomplished and proved."

The establishment of Arkady is a story with a deep human interest. The investigations connected with it have reached from the Mellon Institute into many of the leading laboratories of the country. Scientists of national and international reputation have turned from other work to confirm and extend the facts connected with it, and the yeast food, conservation and better bread making claims, established in the laboratory have been followed on out into the bakeries, large and small, and the facts further demonstrated under the joint supervision of the scientists and baking experts in actual bakings. The opponents of Arkady have pulled it from the scientists and public health boards into politics, where thinking and independent majorities in the legislative bodies where it was brought to trial have pronounced in its favor. Wherever scientist or baker, legislator or editor, army officer or mess sergeant have looked into its facts, have seen its bread making results, it has won on its merits and on the level.

Arkady is new in application; old in principle. It puts nothing new into bread; nothing that flours, salt, waters, malt extracts, milk and other ingredients do not put into bread. But it was a new way, with a definite, dependable, measurable, and temporarily competing result. It was thought that it would hurt yeast. Yeast experts, of long experience in the science of fermentation, said that the Arkady salts would not feed yeast. Today one of the Arkady salts is being used in the production of a large part of the yeast supply. And so, at first an aid to yeast in the making of bread, one of its salts has become an aid to the yeast maker in making yeast; it has revolutionized yeast making.

One of the salts in Arkady is calcium sulphate, refined, soluble calcium sulphate. Bread, as pointed out in the chapter on the food value of bread is deficient in calcium. Wheat is richer in phosphates, and phosphates need their calcium balance, both for better yeast action and for better human nutrition. All of the calcium salts were tried out; but the little, mysterious yeast plant seemed to like best, to thrive best with the lime salt, calcium sulphate. This salt was chosen as basis for the attack against the process, and in 1915 Arkady was hailed before the Public Health Committees of the Massachusetts Legislature. No one could pronounce it unwholesome; no one would say that it lowered the nutritive value of the bread. The only thing its opponents could find wrong with it was that it was new and the opposition secured the passage of an act which named a list of baking ingredients that could be used without labeling and required any ingredient "not commonly sold at retail as food to be labeled." Since Arkady was new the loaves of bread containing it were labeled, but consumers continued to eat the bread.

In 1917, the law of 1915 having failed of its trade fight purpose, the attack on Arkady was renewed before the Massachusetts Legislature. The Ward Baking Company went before the committees and legislature with the wealth of fact which it had accumulated behind Arkady, and went to the public with these facts through an extensive advertising campaign, and not only defeated the bill by a decisive vote but greatly increased the sale of its bread.

Among the American experts that have investigated and confirmed the Arkady facts are the following:

Dr. Robert Kennedy Duncan, and Drs. H. A. Kohman and Charles Hoffman, who conducted the investigation leading to its discovery, and

Dr. Raymond F. Bacon, Director Mellon Institute, Pittsburgh.

Dr. Alice G. Blood, Professor of Nutrition, Simmons College, Boston.

Dr. Wm. F. Boos, former Expert for Federal Government in Physiological Chemistry and Medicine, Boston.

Dr. Frederick E. Breithut of the College of the City of New York.

Miss L. A. Cauble, Investigator for New York Association for the Improvement of the Poor.

Dr. Worth Hale, Professor of Pharmacology, Harvard Medical School, recently with Federal Bureau of Public Health; Government Expert in many Pure Food and Drug cases.

Prof. Carl Miner, Chief Miner Laboratory, Chicago.

Prof. Herbert R. Moody, College of the City of New York.

Dr. James F. Norris, Professor of Chemistry, Mass. Inst. of Technology.

Dr. Wm. H. Walker, Professor of Chemistry, Mass. Inst. of Technology.

Dr. C. E. A. Winslow, Professor of Public Health, Yale University.

Dr. A. G. Woodman, Professor of Food Chemistry, Mass. Inst. of Technology.

In 1917 Professor John P. Street, State Analyst of Connecticut, referee on bread for the joint food standards commission appointed from the United States Department of Agriculture, the American Associations of State and Federal Pure Food and Drug Officials, and Association of Official Agriculture Chemists, and acting as State Analyst for Connecticut, made a thorough investigation of yeast food, and particularly of the mineral salts contained in Arkady because of the newness in application to bread. Professor Street's report is published in the 22nd report on Food Products of the Connecticut Agriculture Experiment Station, Bulletin 200, December, 1917. Professor Street deals directly with Arkady. On the question of conservation, Professor Street says:

"In every test the non-Arkady breads showed the greater loss in dry matter. This ranged from 1.340 to 21.006 lbs.; the Arkady breads showed losses of from 0.675 to 13.155 lbs.; in both cases the losses varying to a considerable extent with the amount of flour used. The percentage loss of dry matter in the non-Arkady breads ranged from 2.41 to 5.12 and in the Arkady breads from 0.53 to 3.25. Although there are considerable variations in the decreased losses of dry matter where Arkady was used, it is a striking fact that in every test the Arkady bread showed a lower loss, ranging from 0.60 to 2.49, average, 1.60 per cent.

"In other words, in making 2,414 loaves of bread weighing 3,505 lbs., the use of 11.878 lbs. of Arkady allowed the saving of 22.93 lbs. of flour, 10.125 lbs. of sugar, 2.875 lbs. of salt, 14.00 lbs. of yeast and 1.00 lb. of malt extract, or a total net saving in raw materials of 39.052 lbs. At the same time 40.15 lbs. of the dry matter of the dough was saved from unnecessary destruction by the yeast ferments. Calculating these results to the basis of 1,000 1.5 lb. loaves of bread, the saving in ingredients following the use of Arkady were as follows:

Saved			*Used in Addition*
9.50	lbs.	flour	4.92 lbs. Arkady—
4.19	"	sugar	
1.19	"	salt	
5.80	"	yeast	
0.41	"	Roloco	

In addition to the above, 16.63 lbs. of the dry matter of the dough was saved per thousand 1.5 lb. loaves. When one considers the millions of loaves of bread made annually such a conservation as is shown by tests is well worthy of careful attention."

On the general food value and wholesomeness Professor Street states:

"It is apparent, therefore, that the use of Arkady does not increase the moisture content of the bread, that it slightly increases its food value, and that it in no way decreases the bread's digestibility."

Every pound of yeast during its period of active fermentation in the bread dough burns up an average of four pounds of flour in producing leavening gas. Think this big fact over. Four barrels in every hundred barrels of flour are burned up by the yeast into gas. Only one-half of this gas is needed to raise the dough. The other half is WASTE.

Arkady Yeast Food stops this waste and it saves for the general food supply of the country out of each year's supply of baking materials

—Six Months' Supply of Yeast

—Two Months' Supply of Sugar

—One Week's Supply of Flour

In the extensive investigations surrounding Arkady Yeast Food, American scientists and baking experts have just completed the most thorough and exhaustive study of fermentation losses in bread making ever made. Seventy-six of the baking tests made were checked by two or more independent experts. The average American bread formula was followed: thirty-eight of the bakes were made with the usual amount of yeast and no Arkady and thirty-eight of the bakes with Arkady and but one-half of the usual amount of yeast.

The average percentage of fermentation loss of *dry*, water-free flour material burned up by the yeast in the production of leavening gas stands in these tests as follows:

Without Arkady Yeast Food 3.9%
With Arkady Yeast Food 2.3%

Conservation of Food Material in favor of Arkady 1.6%

Sample loaves of known weight were taken for moisture determinations. The results of the analysis of tests show fermentation losses in detail in percentage of dry material as follows:

	Per cent Loss *Without Arkady*	Per cent. Loss *With Arkady*
Hoffman Analyst, Ward Plant	4.73	3.84
" " " "	4.03	2.38
" " " "	3.49	1.99
" " " "	3.82	2.16
" " " "	2.78	2.18
" " " "	3.31	2.70
" " " "	3.48	2.31
New Haven Plant	2.32	1.50
U. S. Army Washington Barracks	3.60	2.19
Indianapolis Plant	3.4	2.05
Street Analyst, Ward Plant	3.45	2.17
" " " "	3.10	1.80
" " " "	2.51	1.26
" " " "	2.61	2.01
" " " "	2.85	0.83
" " " "	5.16	3.41
" " " "	4.07	2.09
New Haven Plant	3.34	1.29
U. S. Army Washington Barracks	3.60	2.19
Miner Analyst, Chicago Plant	1.90	0.65
" " " "	3.69	1.64
Robinson Analyst, Detroit Plant	6.6	4.39
" " " "	5.53	1.24
" " " "	3.18	0.91
" " " "	5.66	2.76
" " " "	5.77	4.21
" " " "	3.55	1.87
" " " "	6.35	4.6
" " " "	7.28	2.69
" " " "	1.34	1.01
" " " "	2.45	.79
" " " "	3.09	1.07
" " " "	2.48	.50
" " " "	4.88	3.55
" " " "	4.23	2.02
" " " "	6.34	4.97
" " " "	5.56	5.32
" " " "	4.10	3.41

The use of Arkady in bread making,

Saves Yeast to the extent of 50 per cent. of the amount usually required.

Conserves Flour and Sugar: From 1½ to 2 per cent. of the flour and from 15 to 20 per cent. of the sugar usually added to the dough batch are saved from destruction by the yeast into unnecessary leavening gas.

Produces a Better Loaf with better flavor through a better fermentation in the dough, with more spring and life in the oven, resulting in a loaf of better texture and bloom.

How these claims have made good with the bakers is shown in a letter from a scientific service for bakers to its clients in August, 1920, as follows:

"Our laboratory, our expert bakers, and all of our big list of clients who subscribe for our technical service, agree that ARKADY is one of the greatest discoveries of the age.

It has made its way by sheer merit, in the face of skepticism and, at times, of violent opposition. Today the largest and best informed bakers in the country use it.

It DOES save yeast and it DOES save sugar. These savings more than offset its cost.

But the big thing is that it makes better bread.

We KNOW that ARKADY will give you better control of your fermentation, more spring in the oven, better texture, better flavor and bloom.

Besides, it will save flour, sugar and yeast far beyond its cost. Here, then, is BETTER BREAD AT LESS COST."

At the Washington, D. C., barracks in the heat of the summer of 1917 Arkady was given its first test in the Army. It was a severe test. The mixing was done by hand, the doughs raised and proved in a tent and baked in a portable field oven. Two doughs were carried through, one with the usual amount of yeast used in the Army formula, and one with one-half the usual amount of the yeast and one pound of Arkady per barrel of flour. When the loaves came from the oven the superiority of the Arkady loaf was outstanding. Baking tests were made in seventeen more Army camps, and the result is told in a letter to the Company from a Lieutenant Colonel in charge of the Army baking, as follows:

"I am glad to advise you that the Quartermaster General of the Army has instructed purchasing Quartermasters to carry yeast food hereafter in the local commissaries for use in bread making in the Army Bakeries.

In this connection, I wish to state to you that I have tried out, under my personal supervision, the use of Arkady Yeast Food and found it came up to all that was claimed for it by its manufacturers.

I take this occasion to express my appreciation of the patriotic offer of the Ward Baking Company to allow the Government to purchase Arkady Yeast Food at the cost of manufacture during the period of the existing war."

After this the Government sent some three million pounds of Arkady over-seas. Each pound of this Arkady saved the shipment of around four pounds of the grain consumed in making a pound of yeast, protected two pounds of flour from fermentation loss and made a better loaf of bread for the soldier. In the Amaroc, an official daily newspaper of the American Army, in its issue of May 1st, 1919, a writer on "How Good Bread Is Supplied For Army," states:

"The month of April in the Coblenz bakery saw an average output which is maintained by the 12 other bakeries of the Third Army which cover all parts of the area. During the month, 650,000 pounds of flour were used with other ingredients to produce 825,000 pounds or 412,500 loaves of light and delectable white bread. With the huge amount of flour was used, 9,500 pounds of sugar; as many of salt and lard; and 3,200 pounds of yeast, to make bread for the troops of the Coblenz area. This large output also necessitated the use of 4,700 pounds of Arkady Yeast Food."

Another instance is in a letter from an Army Sergeant, as follows:

"The way I knew about Arkady, I was in the Army and was a baker. I used hundreds of sacks of Arkady Yeast Food and we baked good bread and when I came home I wanted the same kind of bread. I wouldn't think of baker's bread without it."

Such, in brief, is the story of Arkady. As the letter from the scientific baking service company just quoted says:

"It has made its way by sheer merit in the face of skepticism and, at times, a violent opposition."

But all of this is over, and the process not only stands as one of the foremost advances in the science of baking, but a new policy in trade has been established. The Ward Baking Company is putting the well tried-out results of its research at the disposal of all of the bakers, not only to bakers in territories where it does not sell bread, but equally so in territories where it sells bread on the basis of a reasonable profit; in fact, a far greater profit to those who use it than to those who make it.

Private research must be financed. Patent protection is the reward which the Government has established for those who are willing to seek facts and apply them to useful purpose. The use in baking of the mineral salts contained in Arkady Yeast Food have been patented. The next chapter will be the establishment of the Arkady patent rights in the courts, against that minority in the field of trade who, without sowing, without hoeing and cultivating, risking and waiting, are, nevertheless, ever present to make appropriations to themselves after the usefulness of the invention has been established.

THE STORY OF AN AMERICAN BUSINESS SUCCESS

THIS is a story of an American business success—a story of Ward's Bread and how, from a modest beginning in a small, old-fashioned building and an output of a few hundred loaves a day, the business has grown and grown until today Ward's products are made in fifteen huge, modern and sanitary bakeries with a combined daily output of over a million loaves of bread and a quarter of a million cakes.

It was in 1849 that Hugh Ward arrived from Ireland and opened a bakery in a small building on Broome Street, New York City, a photograph of which is reproduced at the top of this page. A few years later he decided to locate in Pittsburgh, Pa., which decision he carried out and in a short time was again engaged in the bread business and introducing to the people of the then "smoky city" Ward's Bread.

At the early age of eight years, Robert B. Ward, the son of Hugh Ward, and founder and organizer of the present company, owing to the great scarcity of labor, caused by the civil war which was then in progress, was obliged to assist his father in the bake-shop and from that time up to the age of twenty-one years, less the time spent in public school, devoted himself to acquiring an expert and practical knowledge of bread making.

A few years later he bought out a small bakery and started in the bread business for himself in that section of the city of Pittsburgh known as the "East End." In later years he associated with himself his youngest brother, George S. Ward, who had succeeded his father and knew what it was to bake and deliver bread before going to school each morning, and together they formed the firm of R. B. Ward & Company. The company thus formed was remarkably successful and continued to prosper until in 1897 its growth and expansion had reached such proportions that more capital was required and so the firm of R. B. Ward & Company was merged into a company known as the Ward-Mackey Company.

The business of the new company continued to increase and it was soon recognized that it would be necessary to enlarge the manufacturing facilities to keep up with the ever growing demand for Ward's Bread. The Wards, therefore, decided to erect a modern, sanitary, bread making plant and this resolution was realized on July 7th, 1903, on which date their modern Pittsburgh bakery began the making of Ward's Bread. So far ahead of other bread making establishments was this new plant and so complete and up-to-date its equipment that today, seventeen years after its erection, it still stands in the front rank among model bread bakeries and a tribute to the enterprise and farseeing business intelligence of Mr. R. B. Ward and Mr. George S. Ward, the men who had the courage and the pioneer spirit to erect the first sanitary and scientific bakery in America.

The popularity of Ward's Bread in Pittsburgh increased by leaps and bounds and not long after the opening of the new Pittsburgh bakery it was decided that, since Ward's Bread had become the leading seller in the Pittsburgh district there was no reason why its quality, purity and cleanliness should not find equal favor among the people of other cities. And so, the next few years witnessed the further growth of the company and bakeries were built and successfully operated in the cities of Chicago, Cleveland, Boston and Providence.

In 1911 the Wards decided to return to New York where their father and grandfather had first begun business in this country. In that year they organized the Ward Baking Company and erected in the cities of New York and Brooklyn two immense plants with a combined capacity of over a half million loaves a day. The opening of these wonderful bakeries and the announcement of the Wards that they proposed to supply the people of Greater New York with bread which surpassed all other kinds in quality and purity and above all, in cleanliness, was welcomed by the people of the metropolis, who immediately responded with liberal patronage as proof of their appreciation.

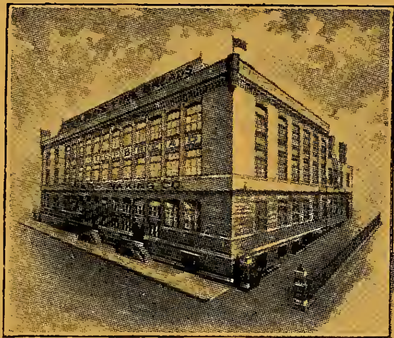
And true to their promise the Wards *did* make and offer for sale a loaf of bread—the famous Tip-Top bread—which in texture, taste and cleanliness, eating qualities and keeping qualities was far superior to any loaf ever bought by the people of the world's greatest city.

Another distinctive feature of Ward's Tip-Top Bread was the method of delivering it. Horses, harness and stables had no place in the Ward way of delivering the staff of life. Since the bread was made amid surroundings of spotless cleanliness it was resolved to practice the same rule in the delivery of it and so every loaf was delivered in electric motor vehicles driven by clean cut, healthy salesmen, uniformed and gloved in white.

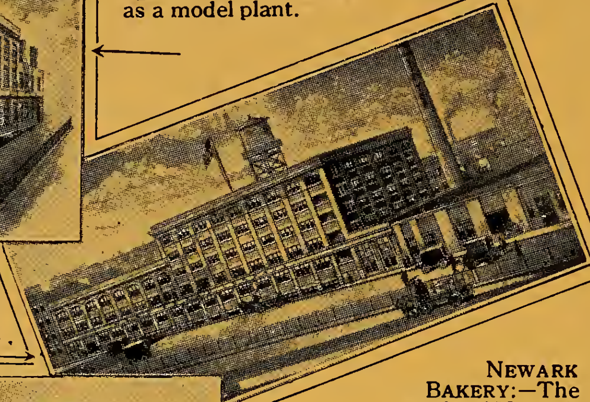
A short time later another huge plant was erected in Newark, N. J., to supply the people of that city and other New Jersey towns with Ward's Bread and this bakery, too, is a real Ward establishment and like the other bread making institutions bearing the Ward name, a veritable snow-white temple of cleanliness.

Ward's Bread was made when the tallow candle was still a utility in almost every home. Long before the advent of the incandescent lamp, the telephone, the telegraph and even the sewing machine it was the daily bread of many American families. Ward wagons in those days rattled over cobble paved streets, passing flickering gas lamps on their early morning delivery of bread to the dealers. Day by day since that time it has grown in public favor. Today there are sixty-six kinds of Ward's bread and rolls and twenty-three kinds of Ward's Cakes, all made "the Ward Way," the "Clean Way," in fifteen modern bakeries located in the cities of New York, Brooklyn, Newark, Chicago, Cleveland, Pittsburgh, Boston, Providence and Baltimore.

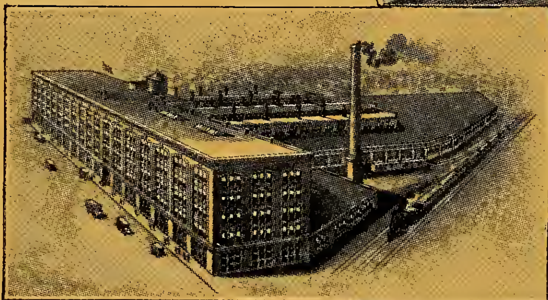
The rise of this great business from obscurity to the proud position it holds today is a monument to the courage of those who founded it and carried it on to its present day supremacy and their constant maintaining of the product to the company's standard of "Quality, Purity and Cleanliness."



PITTSBURGH BAKERY No. 1:—The first modern sanitary bakery to be erected in this country. Built sixteen years ago and still recognized as a model plant.

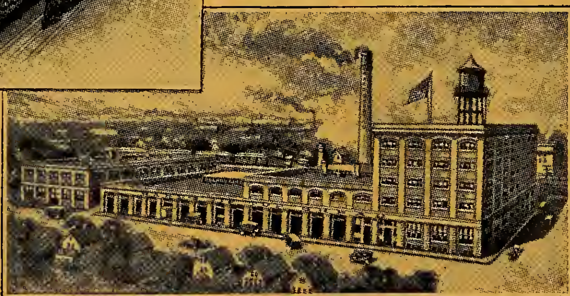


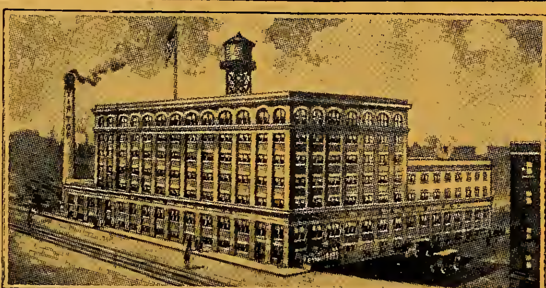
BROOKLYN BAKERY:—One of our three great plants which supply millions of people residing in metropolitan territory.



NEWARK BAKERY:—The people of Newark and surrounding New Jersey towns are justifiably proud of this huge and beautiful bread-making establishment. It is one of the industrial sights of that district.

CHICAGO BAKERY No. 2:—This photograph of our Chicago No. 2 plant presents evidence that Ward's Bread is made in that great city, as elsewhere, amid surroundings of spotless cleanliness and by the most modern methods.





NEW YORK BAKERY:—Erected in 1911 at a cost of over two million dollars. Has a capacity of two hundred and fifty thousand loaves per day. Admitted the world's greatest bakery and known as "the snow-white temple of bread-making cleanliness."