BULLETIN 118. January, 1902

Ontario Agricultural College and Experimental Farm.

YEAST AND ITS HOUSEHOLD USE.

By Prof. F. C. Harrison.

INTRODUCTION.

In the process of bread-making, the management and control of the yeast and its fermentation is usually the least understood part of the operation; and it is owing to mistakes in its treatment that the greater number of failures in bread-making are due. No manipulation of the flour or dough will compensate for weak or badly prepared yeast. The other factors of uncertainty in bread making consist chiefly of insufficient care in kneading and the differences in the quality of flours.

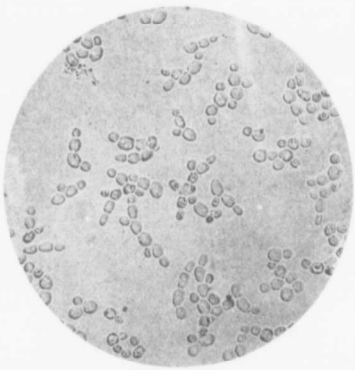


Fig. 1.—Distillery Yeast; from a young culture; magnification, 400 diameters.

This bulletin is written more especially for those who make bread in their own homes; it may also be found helpful to professional bakers who have not had time or opportunity to study the subject. The results of some experiments made in the Bacteriological Department of the Ontario Agricultural College are given.

FERMENTATION. The term "fermentation" is, as a rule, confined to the production of alcohol from liquors and substances containing sugar, but the word is now extended so as to denote many other changes caused by the action of micro-organisms; for instance, the germ causing the souring of milk is often spoken of as the lactic ferment, and the changes which it causes constitute the lactic fermentation; in the same way, the production of vinegar, or acetic acid, is caused by a microbe, and the wine or other substance from which it was made, is said to have undergone acetic fermentation.

In this bulletin, the fermentation of flour is frequently referred to; and by the term it is meant that the sugar contained in the flour is acted upon by a living organism—the yeast plant—and is changed into alcohol and carbonic acid gas, the same gas which is contained in beer and causes it to froth. This gas is formed in the beer by the action of the yeast upon the sugar contained in the malt. The alcohol remains in the beer, but disappears from the bread, being evaporated by the heat during baking.

PUTREFACTION. This term is usually applied to substances which are decomposing and producing a bad odor; when no bad odor is produced in the decomposition the words decaying or rotting are generally used to describe it. There are stricter limitations to the meaning of these words when used in a bacteriological sense, but they need not be given here. It is difficult, if not impossible, to draw any clear distinction between these processes, and that of fermentation. They are all caused by the action of minute vegetable organisms, and all lead to the same result, which is the decomposition of dead organic matter into its chemical constituents, so as to furnish food available for growing plants. This change is constant in the manure applied to land for a coming crop. Every farmer knows that manure must rot, either in the barnyard or in the earth, before the plant can derive any benefit from its application. The crop feeding upon this decaying manure grows up, and is then either eaten or decays where it grows. If it is eaten, a portion of it is excreted as manure and a portion goes to form the flesh of the animal consuming it; the manure undergoes the same process of decay, the flesh gradually wastes during life, and the waste products are thrown off into the air; and when the body dies it decays, forms a portion of the soil, and is again available for plant food.

In order that this process of putrefaction may go on, four things are necessary:

1. The substance to decay.
2. The bacteria to cause decay.
3. A suitable temperature.
4. Moisture.

These are all present in the dough or sponge state of bread-making, as it is desirable to provide the best conditions for the growth of the yeast; and, of course, if other organisms are present they will also grow rapidly and produce sour bread and other defects. Hence great care should be taken to prevent bacteria from gaining access to

the flour, yeast, or dough. It will be shown later on in this article, where bacteria are most likely to be found and how they may be killed or controlled.

BACTERIA. When any dead animal or vegetable substance is left exposed to the air, it immediately commences to decay, if it is at all moist. This change is caused by the growth in it of minute organisms called microbes, micro-organisms, or bacteria. These organisms are the most simple forms of life in the vegetable kingdom. They increase very rapidly by simply dividing into two; and each half then grows and again divides. In some cases, as in the ripening of cream and milk for butter and cheese-making, certain forms of bacteria are necessary in order to obtain good results; but in bread-making, yeast (not a bacterium) is used to ripen the dough, in a manner somewhat similar to that in which a "starter" (or sample of milk containing desirable bacteria) is used in the dairy business to ripen the cream. Other organisms, such as moulds and bacteria, are undesirable and often harmful in bread-making While there is no way by which, in practice, the flour can be freed from bacteria, yet the yeasts and utensils may be kept comparatively free from them, if the conditions under which organisms grow and increase are understood. Few bacteria will be found where yeast tubs and all utensils are kept perfectly clean and are frequently scalded; but when the yeast is grown in an old tub or is stirred round with dirty hands (which is very frequently done by bakers who think they understand how to make bread, but are puzzled to know why their make is so often sour or dark in color) there is certain to be poor-flavored bread very often.

HISTORICAL. The earliest bread makers used nothing with their crushed grain to make it rise; hence their bread was hard and solid, and so had to be in thin cakes. Ching Noung, the successor of Fohi, is reputed to have been the first who taught men the art of husbandry and the method of making bread from wheat, and wine from rice. Fermentation was made use of at the time of Lot, for we read that "He did make them a feast and did bake unleavened bread." Baking reached a high state of perfection in Egypt. It became a profession at Rome, 170 B.C. After the conquest of Macedonia in 148 B.C., numbers of Greek bakers came to Rome, secured special privileges, and soon obtained a monopoly. Later, a special magistrate was appointed to superintend the public bakeries. Pliny states that the Romans used a leaven composed of grape juice and millet which kept for a year. This leaven doubtless contained a large quantity of yeast, as yeast is always found upon the surface of ripe grapes. From Rome the method of bread making spread gradually with civilization; and at present, fermented bread is in general use, except in a few of the northern countries of Europe, and in other places distant from civilization.

THE YEAST PLANT.

Yeast belongs to that division of the vegetable kingdom known as *Fungi*,—a class or group of plants which do not possess any chloro-

phyl (or green coloring matter), and which therefore must obtain their nourishment from organic matter.

GROWTH. The yeast plant consists of a single cell, which, when it reaches a certain size and is kept under suitable conditions, sends out a bud from some part of its surface, which gradually increases in size. This bud may or may not remain attached to the old cell. If it does so and if the old cell continues to send off more buds, a mass of cells is soon formed; but if each cell as it grows produces a bud, a long chain of cells is formed

SPORES. Under certain conditions, (moist surface, plenty of air, favorable temperature, and vigorous cells), small round bodies, from two to eight in number, are formed inside the old cell, which bodies are called spores. (See Fig. 2.) These may remain dormant

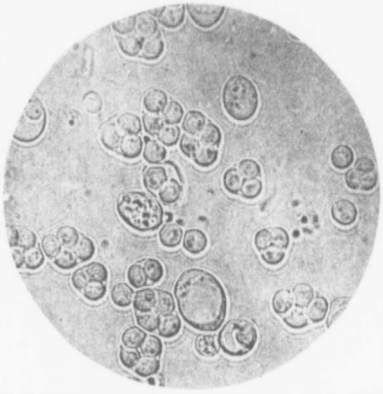


FIG. 2.—A wine yeast shewing spore formation; magnification, 1,000 diameters. From 2 to 4 spores may be seen in most of the cells.

for a considerable length of time, but will germinate when placed in suitable food. They are usually more resistant than the cells in a vegetative condition. The ordinary yeast cell lives for a considerable length of time when it is kept dry.

FUNCTION. Yeast is mixed with the flour to cause the dough to rise, and by so doing to make the bread more palatable and digestible; and the rising is caused by the separation of the particles of the flour by the gas formed as a result of the action of the yeast upon the sugar contained in the flour, and it enables the digestive fluids to act more readily upon them; the yeast also acts to a slight extent upon the gluten of the flour, causing it become softer and less like rubber. Yeast also gives to the bread a distinct flavor which cannot be obtained in any other way.

VARIETIES. There are a large number of varieties of yeast, and, as in the case with other plants, some varieties are more suitable for use than others. Yeasts of different varieties are used in the manufacture of fermented liquors, such as beer, whisky, wine, cider, etc. No doubt any of the yeasts would cause fermentation in flour to a greater or less extent during the process of bread making, but some would require twelve to fourteen hours to cause the dough to rise to the same extent as another would in seven or eight hours. Many kinds produce a bad flavor; others a bad color in the loaf; and for these reasons, it will be seen that it is a matter of importance to use only a yeast which is suitable for bread making. This is specially important for persons who grow their own yeast; and those who do so, may select from the various brands upon the market, by making small sponges with each kind of yeast, being careful to put into the sponge equal quantities of flour, water, and yeast. Of the different lots, that which gives the best fermentation is selected; or bread may be made from each and the results compared, in which case the yeast giving the best results is used to start the brew with.

BAKERS' YEAST.

Yeast is sold for bakers' use in three forms:

1. COMPRESSED YEAST. This yeast is put up in the form of moist cakes, and should consist entirely of yeast cells. It is usually a distillery yeast (see Fig. 1), most of the moisture having been pressed out by a mechanical process. There are yeast factories where yeast is made as the chief product, the fermented liquor being only a secondary one, and these factories should produce a much purer yeast than they usually do. The compressed yeast examined in our laboratory has invariably been more contaminated by moulds and bacteria than the yeast from breweries and distilleries.

The term "*purity*" of yeast is used here in a biological sense, and does not refer to any chemical or other substance, such as starch or corn meal, which are frequently mixed with the dried yeasts.

The compressed moist yeast keeps, as a rule, only for a few days. Some of the manufacturers state, however, that it will keep for a month or so, if placed under cold water so as to be kept from the air. This form of yeast generally gives the best results, and it is more easily used than other forms; but, owing to its poor keeping qualities, it is not suited to the use of persons living in the country. In towns it is usually distributed by the manufacturers every two or three days. When fresh it should have a pleasant, wine-like smell, and should break with a sharp grain, and not be at all sticky or putty-like.

2. DRIED YEAST. The dried yeast cake is the best form in which yeast can be obtained for the use of those who live in the country or in places where it may be necessary to keep the yeast for some

length of time. Being dry the cakes cannot decay, as bacteria are unable to grow where moisture is absent; but if the cakes are kept too long, the yeast will lose its vitality and die.

Dry yeast is often sold in the form of a powder, being mixed with the grains and hops used in its cultivation in the yeast factory.

3. Brewery, or Liquid Yeast. Yeast is often sold by brewers to local bakers. It grows in the fermenting vats of the brewery, and is either a "top fermentation yeast," which rises to the top of the vat, or a "bottom fermentation" yeast, which sinks to the bottom. In the former case, the yeast which is first skimmed off should not be used for bread-making, as it always contains a large quantity of impurities, such as pieces of dirt, dust and bacteria; the yeast collected at the middle of the fermenting periods is the more vigorous, and that which is obtained last is often weak, and does not always give satisfactory results. Brewers' yeast sometimes gives a bitter flavor to bread; but it is said that this may be got rid of by washing the yeast in cold water and allowing it to settle, the water being then poured off.

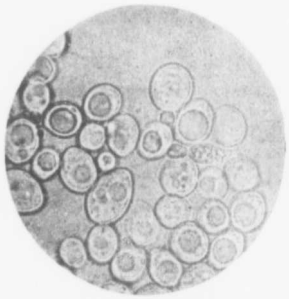


Fig. 3.—Fresh Brewery Yeast; magnification, 1,000 diameters.

It is probable that those who use large quantities of yeast will find it more economical to grow their own, especially if a man is employed who thoroughly understands its management; the expense will be far less than if the yeast is purchased, the cost of the materials necessary for the growth of a pound of yeast, being much less than that of a pound of compressed yeast; and by the use of the hops and malt used in the yeast brew a characteristic nutty flavor is given to the bread, which cannot be produced in any other way. In bakeries where various kinds of bread are made, both kinds of yeast may advantageously be used; but unless the principles of yeast growing are thoroughly understood, it will not be advisable to make experiments where large quantities of bread are made.

Laboratory Tests.

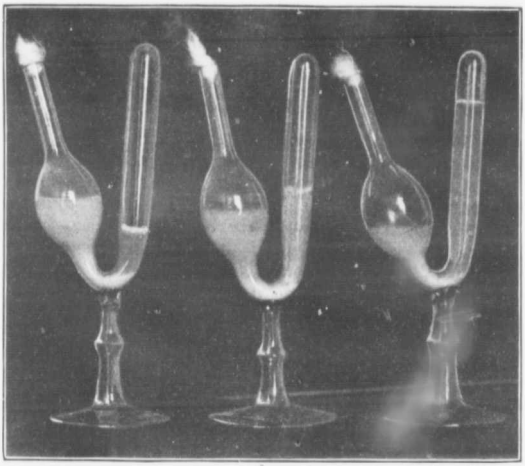
Yeasts Used in Laboratory Experiments. Yeasts were obtained from twenty-eight sources and tested for fermentative power:

From breweries, eight, which had been used in making ale.

From breweries, three, which had been used in making lager beer.

From whiskey distilleries, four.

Nine, which had been put upon the market for bread-making purposes.



1 2 3

Fig. 4.—Fermentation tubes containing flour and water—
1. With addition of a distillery yeast.
2. " " brewery yeast,
3. " " dried cake yeast.

Note, in the right arms of the tubes, that there is more gas in 1 than in the others, shewing the more energetic working of the distillery yeast. For the same reason there is more gas in 2 than in 3.

One, which was isolated in making a bacteriological examination of a sample of malt extract.

Two obtained from bakers who grew their own yeast.

One obtained in making a bacterological examination of Stilton cheese.

In the test made for rapidity of fermentation, there were three which gave a much more rapid fermentation than any of the others, and which were considered to be equal. One of these was from a

distillery, one from a compressed yeast (sold for bread-making and ordinarily produced at a distillery), and the third from a home-grown yeast which had been started with a compressed distillery yeast.

The beer yeasts in several instances gave better results than yeasts sold specially for bread-making. Some of the latter gave very poor results, indeed, showing that sufficient care had not been taken when starting the growth of the yeast at the factory to obtain one which was well adapted to bread-making The experiments show the superiority of distillery yeasts over brewery yeasts for the fermentation of flour. They seem to act upon the starch of the flour more energetically than do the beer yeasts.

In experiments made on mixtures of flour and water in fermentation tubes, the distillery yeasts always produced considerably more gas than did the other kinds; they also produced the gas more quickly. (See Fig. 4.)

Action of Yeast.

The most striking change in dough after the addition of good yeast is the rising or swelling of the mass. This is caused by the action of the yeast upon the sugar which is present in the flour, and to a slight extent upon the starch, which has been changed into a kind of sugar called dextrin, chiefly by the diastase in the flour. These sugars are converted into alcohol and carbonic acid gas. The alcohol may usually be plainly smelt by making an opening in the dough at the end of the doughing stage; but it is evaporated on heating the dough in the oven during the process of baking. Small quantities of it, however, are said to be retained in the bread. The gas which is formed in the dough during fermentation is unable to get away, owing to the sticky nature of the flour. It is held in small bubbles, the form of which can be seen on looking at a piece of bread, the small holes representing the spaces occupied by the gas bubbles in the dough. The effect of the heat in the oven upon these bubbles is to cause them to expand, and thus force the particles of flour farther apart, so that the loaf when baked is much larger than the piece of dough before baking.

Other changes occur which are not clearly understood, and which result in the production of "grain" or texture in the loaf. If a dough is set and a portion is taken off and baked at the end of, say six hours, and other portions taken at eight and ten hours, respectively, those which have been taken too early will not produce bread of so good texture, flavor, or color as those taken later; but if any portions are left too long the bread made from these will be crumbly and brittle, owing to the fact that the gluten has been stretched so much by the gas that it is unable to hold the particles firmly together.

Properties of Yeast.

Fermentative Power. The most important function of yeast is to form gas and thus raise the dough; and some yeasts form very

much more gas in a given time than others. Figure 4 shows the effect of different yeasts upon equal quantities of the same grade of flour mixed with the same amount of water and kept under the same conditions during fermentation.

The strength of any yeast may be much lessened by improper treatment before mixing with the flour. This is most frequently seen when home-brewed yeasts are used; and the yeast is then said to have run out or lost strength. This is usually due to the fact that it has not had a sufficient quantity of suitable food, or has been kept at too high a temperature during its growth in the yeast tub. In two samples of yeast sold for bread-making in the form of dried cakes, composed of yeast cells and corn meal, no living yeast could be found. It had most likely died from being kept too long without moisture.

The form which the yeast is in when added to the flour determines very largely the rapidity of fermentation. In dried cakes the yeast is usually in a dormant condition, often containing spores; and, as compared with compressed yeast, it contains fewer cells present in the same quantity of material. For these reasons, dried yeasts should be soaked in warm water, in which a small quantity of sugar has been dissolved, to act as food for the cells. Compressed yeast being fresh, the cells are in an active condition, and commence to grow and produce gas as soon as mixed with the dough.

Relations to Temperature. Different temperatures have as much effect upon the growth of the yeast plant as upon that of other plants. A temperature between 75° and 90° F. seems to be the most favorable for gas production in sponge or dough; but the ferment, or yeast brew, must not be kept at a high temperature, or the yeast will become weak,—just as plants in a hot-house, growing at ordinary temperatures, grow more rapidly and flower more abundantly when brought into a higher temperature for a portion of their life, yet gradually weaken if kept there too long. The temperature at which the yeast plant is grown should always be somewhat lower than that at which the sponge is set. Although the above figures are given as being near the limits for good fermentation, still the temperature of the flour and the water before being mixed must always be taken into account, also the time of year and the temperature of the air; as in hot weather fermentation will proceed more quickly than in cold and *vice versâ*. In winter, when the flour is cold, the setting temperature may require to be as high as 95° F.; whilst in summer, the flour being warm, the temperature may require to be brought down as low as 70° F. A thermometer should always be used; and the temperatures should be correctly taken. This is just as important in bread-making as in butter-making and cheese-making.

Purity. The next most important property of yeast is that it be pure, that is, free from moulds and bacteria, as it is to the presence of these organisms that most of the bad flavors and disappointing results are due. It is seldom or never that any bread-making yeasts are met with which are not contaminated to a greater or less extent. This has

been noticed especially in our experiments with the compressed yeasts, of which all the samples examined contained an enormous number of moulds (Fig. 5) and bacteria; and while it is often possible to have a yeast contaminated and still obtain good bread, yet it is almost certain that if the yeast cells become weakened from any cause, the bacteria will increase with such rapidity that bad bread will be the result; but when the yeast is strong and vigorous, it holds many bacteria in

FIG 5.—A common mould (*Penicillum glaucum*), often found in dried yeast cakes. Magnification, 500 diameters.

check and prevents the injury which would be caused by their growth.

An investigation into the cause of ropy bread, conducted at the Wisconsin Experiment Station, proved that bread which became slimy after baking had been made so by the action upon it of a certain germ—*Bacillus mesentericus panis viscosi* (Fig 6)—which is frequently found in the earth. It probably gained access to the bread in the potatoes used in making the yeast, a point which will be referred to later on.

Sour bread, which is of frequent occurrence, is also due to the presence of micro-organisms in the dough It is disputed whether these organisms produce butyric, lactic, or acetic acid; but, for practical purposes, it is sufficient to know that germs are the cause of the souring. The germs may be in the flour, the yeast, or the cracks and corners of the kneading trough, or of other utensils which have not been properly cleansed. It is not possible to free the flour from germs; but experiments have shown that the high grades of flour are almost free from bacteria, and the number of germs increases as the quality of the flour decreases. The yeast may be kept almost entirely pure by proper management; and the utensils may be kept free from impurities by washing and scalding them just as thoroughly as dairy utensils, and with the same object, viz., to kill all germ life.

Methods of Yeast Cultivation.

It is not necessary in this bulletin to go into the manufacture of pressed and dried yeasts, as they are usually prepared upon a large scale and require the employment of a large plant and building. The chief points to be remembered in making a yeast brew are—

1. To start with a pure and vigorous yeast.
2. To maintain a suitable and even temperature at all times.
3. To practise the greatest cleanliness in order to avoid the contamination of the yeast by bacteria.

The number of receipts given for making yeast ferments is very large; and, as the proportions of the constituents differ so greatly, it is evident that they cannot all be correct. Potatoes, flour, malt, sugar, and rice are all recommended; and any of them may be suitable under certain conditions. Those most easily obtainable for use in the home are potatoes and flour. Rice may be used, if potatoes are scarce;

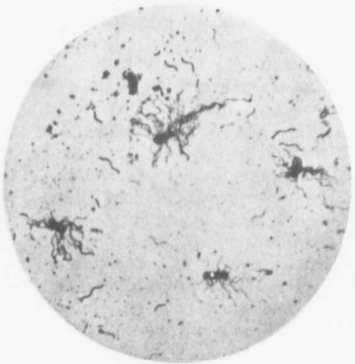


Fig. 6.—*Bacillus mesentericus panis viscosi.*
Magnification, 1,000 diameters.
This germ causes slimy bread.

but it is said to lessen the fermentative action of the yeast. Potatoes are most generally used; and, as a rule, they give very satisfactory results, when care is taken in their preparation They appear to have a very stimulating action upon the fermentative power of the yeast; and one set of experiments made in the laboratory showed that yeast grown in the water in which potatoes had been boiled and then mashed, gave a quicker and more vigorous fermentation than that caused by yeast grown in hopped malt extract, which is usually supposed to be the best medium in which to grow yeast. The

disadvantage in connection with potatoes is that they have been in contact with the earth and possess so many cracks and eyes that they are difficult to free from bacteria always present in large numbers in the earth, and for this reason many large bakers in English towns have given up using them. If potatoes are used, they should be most thoroughly scrubbed in several changes of water, and then boiled or steamed till cooked. It is a common practice to mash the potatoes up with the skins. This is a mistake, and may cause trouble for the following reasons: The boiling will not kill many of the spores of bacteria which are upon the skin; and if the skin containing them is mixed up with the ferment, the spores will commence to grow, and, as has been shown elsewhere, may give bad results. Further, the substance just under the skin consists partly of *solanin*, which, when the potato cools, gives in many cases a rank and bitter taste that may slightly taint the bread. For these reasons, the skins should be thrown away. It is better to boil the potatoes again after peeling them, as by so doing the starch, which, in its raw state, is less capable of acting as a yeast food, may be gelatinised as much as possible.

When flour is used, it is better to cook it than to use it raw, for the same reasons as those for which the potato is cooked, viz. to destroy germ life and to gelatinise the starch. It may easily be cooked by mixing with cold water and bringing to the boil,—the result of which should be a thin paste. If only the highest grades of flour are used, it will be an advantage to use a little sugar. Raw flour is frequently added to cooked potatoes, cooked flour, and malt; but raw flour contains small quantities of diastase, the amount decreasing as the grade of the flour improves; and, as already intimated, diastase has the power of changing starch into sugar. Now, it has already been stated that the lower grades of flour, which contain the largest quantity of diastase, also contain the largest number of bacteria; and, for this reason, it is questionable whether raw flour should be added to a properly gelatinised substance. The starch has to be gelatinised, because in its raw condition it is insoluble, and so cannot be acted upon by the yeast; but when it is gelatinised, the insoluble outer covering of the starch cell is ruptured, and the soluble portion is then available as yeast food.

In places where malt can be obtained it will be found a good substitute for potatoes Yeast grows exceedingly well in malt extract, and it is easily prepared for use. To make the malt extract, the raw malt must first be coarsely ground and then "mashed" in the same manner as is done in breweries On no account should the malt be boiled, as is sometimes done, because the boiling destroys its diastatic power. Malt contains starch and diastase and also sugar. The mashing is performed to cause the diastase to act upon the starch and to convert it into sugar. High heat, accompanied by moisture, will destroy the diastase, and then a great portion of the contents of the malt will be destroyed. Badly prepared malt, that is, malt which has been prepared from grains that have not germinated sufficiently or that have been heated too highly in the early drying stages, does not

contain much diastase. If heated too highly, the malt will be of a dark color. Pale malts have, as a rule, a higher diastase power than dark malts.

"Mashing" consists in keeping the malt mixed with water at a temperature not exceeding 140° F. for a couple of hours. A slightly higher temperature will destroy the diastase, and a much lower one will retard its action. In two hours the grains may be strained off, after having been well stirred up. Malt extract is, however, usually made up with hops, in order to obtain the hop extract.

Preparation and Use of Hops.

In the making of beer, hops are used for three purposes: First, they act as an antiseptic; second, they clear the worts; third, they give a characteristic flavor to the beer. The baker does not, as a rule, wish to flavor his bread with hops, neither does he wish to clarify his ferment, but he does need to have in his ferment an antiseptic; that is, a substance which will prevent bacteria from growing in it; but, while it hinders the growth of the bacteria, it must not affect the yeast in the same manner. The resins contained in hops, and which appear in the form of a fine yellow powder at the base of the bracts of the hop flower, possess the required properties, and have no injurious effects upon those consuming the bread, which is more than can be said of most antiseptics. In order to extract this substance from the hops, it is necessary to heat them in water, but not boil them, at least, not for any length of time, as this will extract a strong, bitter principle, which may cause an unpleasant flavor in the bread. The hops, with the water, should be heated to the boiling point, and there maintained at a slightly lower temperature for about two hours, allowed to stand for a short time, and then strained off. The resulting hop extract may then be mixed with the malt extract, if the latter is sufficiently strong; but the quickest way is to prepare the hop extract, strain it, and cool it to between 130° and 140° F.; then add the malt, and proceed as shown in the previous paragraph. After the mixture has been properly mashed, the whole is boiled for a few minutes in order to kill the germs that may be present; and it is then cooled down to 86° F. as quickly as possible and the yeast added.

The proportion of hops recommended in the various receipts range from 1 oz. of hops in 4 gallons of water to 1½ oz. of hops in 2 gallons of water, or more than half as much again as the former quantity. In order to ascertain the amount of hops which was really necessary, we conducted a large number of experiments on different species of bacteria, using different strengths of hop extract; and the results showed that for practical purposes, 1 oz. of hops in two gallons of water gave as good results as a larger quantity. It must, however, be remembered that the action of the hops depends a great deal upon the stage at which they have been picked, and how they have been grown, dried, and stored. If picked when too green, or if too highly heated in drying, they will not contain as much resin as if properly prepared; and

if not sufficiently dried, they will become musty and impart that flavor to the bread.

No receipts using potatoes with hops were seen in any books, though it is possible that such may be in use. In the laboratory experiments, hopped potato ferment gave apparently good results on a small scale; and there seems to be no reason why such a ferment should not be equally good on a large scale. Its advantage is obvious when we take into account what has been already said about potatoes. The germ *Bacillus mesentericus* (Fig. 6), mentioned in connection with ropy bread, was one of those upon which the hop extracts were tried, and it was shown that they had a great antiseptic power against it.

An addition of salt to the brew is often recommended; but it serves no really good purpose. It has a retarding effect upon the growth of the yeast and very little upon that of bacteria. It should not be added to the flour until the doughing stage. If hops are not obtainable, small quantities of salt, not exceeding ¼ of an ounce to the gallon, may be used and will act as a slight check to bacterial growth.

Receipts for Brews, or Ferments.

It is not possible to give any one or even two or three receipts for brews or ferments which will be suitable under all conditions; but for home baking, the following are submitted as examples; and, with a good yeast, they will give excellent results:

No. 1.—1 lb. potatoes.
½ oz. hops.
1 gall. water.

No. 2.—½ lb. malt.
½ oz. hops.
1 gall. water.

The important point in making a good brew is to boil it before adding the yeast, in order to make it as sterile as possible; and when it is cooled to 75° or 80° F., add the yeast or a portion of the old brew. The vessel in which the ferment is kept should be of such shape that as large a surface as possible of the liquid will be exposed to the air; and the mixture, both before and after the yeast is added to it, should be frequently stirred in order to admit a plentiful supply of air, fresh air having a great effect in increasing the activity of the yeast. The vessel should be supplied with a lid, instead of the usual empty sack which does service as such; a stirrer should be kept in the vessel; and it should be kept for the purpose of stirring only. The stirring should never be done with the hands, as is frequently the case.

Digestibility of Yeast-Fermented Bread.

An important point in bread-making is the effect of the process upon the digestibility of the product. There are ways of making the bread to rise other than by the use of yeast, the most common way being by the use of baking powder and water, or by baking soda and buttermilk or sour milk. These powders are composed of chemical substances,

the former containing sodium bi-carbonate and some acid (usually tartaric acid or calcium phosphate); the latter consists of sodium bi-carbonate alone, the acid being furnished by the lactic acid in the sour milk. Sodium bi-carbonate, when moistened and mixed with an acid, forms a gas, carbon dioxide, which is the same gas as is formed by the yeast cell; but besides the gas there are other substances formed which remain in the bread and which may or may not be injurious, according to the nature of the acid used, and the proportions of the chemicals to one another. If hydrochloric acid is used, as in the case of the manufacture of aerated bread, then only the substances sodium chloride, or common salt, and the gas are formed, if the proportions are correct; but when tartaric or lactic acid is used, a substance is formed, called sodium carbonate, which remains in the bread and is consumed,—which substance has been condemned as injurious to the health when used as a preservative in milk or butter. It is one of the most common remedies in cases of acidity of the stomach and for this reason alone cannot be considered a desirable substance for a healthy person. Every one is familiar with the disagreeable taste and yellowish brown color given to cake when too much soda is used, both the color and taste being due to sodium carbonate which has not been neutralized. But apart from this reason, the flour in bread or cakes so made, is not so digestible as that from yeast-fermented bread; because the starch and other substances are not acted upon by the chemicals in the same manner that they are when subjected to the prolonged fermentative action of the yeast and the diastase contained in the flour; the gluten does not undergo the softening changes that it does under the action of the yeast; and the particles of flour are not so finely divided. Consequently baking-powder cakes are not so light and spongy as bread made in the usual way; and for this reason they are not so readily digested, the coarse particles not offering so large a surface to the action of the digestive fluids as the finely divided particles of well fermented bread.

Aerated Bread. The aerated bread referred to above was first made by Dr. Dauglish. The process adopted by him consists of kneading the dough by mechanical means in an air-tight metal compartment, the dough being thoroughly mixed with carbonic acid gas under pressure while in the kneading trough. The dough is put into the oven immediately after it has been kneaded and rises during the process of baking. The chief advantage of this method is that time is saved, as it is not necessary to wait for the prolonged fermentation of the yeast; and no opportunity is given for undesirable germs to grow and cause sour or bad-flavored bread. Aerated bread is very light, and a uniform quality and good color can always be produced; but it has a raw insipid flavor, which causes the consumer to tire of it.

Salt Bread. There is another method of making risen bread, that is, the method called salt-rising. It is the result of a spontaneous fermentation, and it is therefore a matter of chance whether good bread will be produced, although in places where such bread has been

made for some time there is less liklihood of failure, as the utensils and air of the rooms in which the bread is made contain large numbers of the desirable germs.

Effect of Baking on Digestibility. The action of the heat during baking has a great effect upon the ease with which the bread is digested The outside of the loaf may be heated to about four hundred degrees, thus causing it to become brown. The temperature of the interior of the loaf most probably does not exceed that of boiling water. The highly heated starch on the exterior is converted into dextrin, which is a kind of a sugar and is entirely digestible ; and the fact that this dextrin or sugary substance is thus formed is taken advantage of when making fancy breads that are glazed. The glaze is formed by turning a jet of steam into the oven for a moment while the loaves are hot. The steam combines with the dextrin and forms dextrose, which is the sticky, shiny substance seen on the surface of the loaf.

Note.—Illustrations 1, 2, 3 and 5 from Doyen and Roussell's Atlas de Bacteriologie.