

## Chapter 6

# Fermented Foods

Fermentation in food processing is the process of converting carbohydrate to alcohol or organic acids using microorganisms, yeasts or bacteria-under anaerobic conditions. Fermented foods are rich in probiotic bacteria so by consuming fermented foods the health of gut microbiome and digestive system can increase and also can enhance the immune system.

### Sauerkraut

Sauerkraut is a finely cut raw cabbage that has been fermented by lactic acid bacteria. It is made by a process of pickling called lactic acid fermentation. The cabbage is finely shredded, layered with salt and left to ferment. Fully cured sauerkraut keeps for several months in an airtight container stored at 15°C or below. The fermentation process involves three phases. In the first phase, anaerobic bacteria such as *Klebsiella* and *Enterobacter* lead the fermentation and beginning to produce an acidic environment that favors later bacteria.

The second phase starts as the acid levels becomes too high for many bacteria and *Leuconostoc mesenteroides* and other *Leuconostoc* spp. take dominance.

In the third phase, various *Lactobacillus* species including *L. brevis* and *L. plantarum* ferment any remaining sugars, further lowering the pH. Properly cured sauerkraut is sufficiently acidic to prevent a favorable environment for the growth of *Clostridium botulinum*, the toxins of which cause botulism.

### Tempeh

Tempeh is a traditional Indonesian Soy product made from fermented Soybeans. The principal step in making tempeh is the fermentation of soybeans which undergo inoculation with *Rhizopus* spp. mold *Rhizopus oligosporus*. The beans are spread into a thin layer and are allowed to ferment for 24-36 hours at a temperature around 30°C. The soybeans have to cool down to allow spore germination and abundant growth of mycelium. Later, the temperature of the beans will naturally rise and rapid mold growth happens for about 4 hours. As mold growth declines, the soybeans should be bound into a solid mass by the mycelium. In good tempeh, the

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beans are knitted together by a mat of white mycelium. Typically tempeh is harvested after 48 hours of fermentation with its distinguishable whitish color, firm texture and nutty flavor. During the fermentation process, optimal time of fermentation, temperature, oxygen, humidity and pH levels are required to encourage the growth of *Rhizopus* mold, while discouraging the growth of undesired microorganisms.

## **Miso**

Miso is a Japanese traditional paste produced by fermenting soybean with fungus *Aspergillus oryzae* and salt, and sometimes with rice, wheat or oats. Miso is rich in essential minerals and a good source of various B vitamins, vitamin E, K and folic acid. As a fermented food, Miso provides the gut with beneficial bacteria that help us to stay healthy, vibrant and happy.

Different types of Miso

- White Miso
- Yellow Miso
- Red Miso

Typically Miso is salty, but its flavor and aroma depend on various factors in the ingredients and fermentation process. Miso's unique properties and flavor profile can be attributed to the compounds produced during the fermentation process. Miso, depending on the variety, consists of a starter culture called koji, soybeans, and usually a grain (either rice, barley or rye). The Miso goes through a two step process, first creating the Koji and second the Koji is combined with other components and the mixture is left to be enzymatically digested, fermented and aged.

## **Creating Koji**

Koji is produced by introducing the mold *Aspergillus oryzae* on to steamed white rice. This mold culture comes from dried *A. oryzae* spores called starter Koji. Although other strains of fungi have been used to produce Koji, *A. oryzae* is the most desirable because of a number of properties including the fact that it doesn't produce aflatoxin.

A small portion of wood ash added to the mixture which gives important nutrients to the fungus as well as promotes sporulation. *A. oryzae* is an aerobic fungus and is the most active fermenting agents in koji as it produces amylolytic, and proteolytic enzymes which are essential for creating the final Miso product. To create optimal conditions for enzymatic production and the growth of *A. oryzae*, the Koji's environment must be carefully regulated. Temperature, humidity and oxygen content are all important factors in not only maximizing mold growth and enzyme production, but to prevent other harmful bacteria from producing. Once the Koji has reached a

desirable flavor profile it is usually mixed with salt to prevent further fermentation.

## Natto

Natto is made from soybeans, typically natto soybeans. It is popular in Japan. Smaller beans are commonly used, as the fermentation process will be able to reach the center of the bean more easily. The beans are washed and soaked in water for 12-20 hours to increase their size. The soybeans are then steamed for 6 hours. The pressure cooker may be used to reduce the time. The beans are then mixed with the bacterium *Bacillus subtilis*, known as natto kin in Japanese. The mixture is fermented at 40°C for up to 24 hours. Afterward the natto is cooled, then aged in a refrigerator for up to one week to allow the development of stringiness. When *B. subtilis natto* breaks up soy protein, the bacteria create chains of poly glutamic acid, gamma polyglutamic acid. Natto gets its stringiness from the gamma polyglutamic acid. Its odor comes from diacetyl and pyrazines, but if it is allowed to ferment too long, then ammonia is released.

## Kombucha

Kombucha is a fermented tea that has been consumed for thousands of years. It is also rich in beneficial probiotics. It also contains antioxidants, can kill harmful bacteria and may help fight several diseases. Kombucha is produced by fermenting sugared tea using a symbiotic culture of bacteria and yeast (SCOBY) commonly called a “mother” or “mushroom”. The microbial populations in a SCOBY vary, the yeast component generally includes *Saccharomyces cerevisiae* along with other species. The bacterial component includes *Gluconacetobacter xylinus* to oxidize yeast produced alcohols to acetic acid and other acids. Although the SCOBY is commonly called “tea fungus” or mushroom” it is actually a symbiotic growth of acetic acid bacteria and osmophilic yeast species in a zoogloeal mat.

## Kimchi

Kimchi is a national dish of both North and South Korea. Cabbages and radishes are the most commonly used kimchi vegetables. Brining salt (large grain size compared to kitchen salt) is used mainly for initial salting of kimchi vegetables. Salt, Scallions, garlic, fish sauce and sugar are commonly added to flavor the Kimchi. Microorganisms present in Kimchi include *Bacillus mycoides*, *B. pseudomycoides*, *B. subtilis*, *Lactobacillus brevis*, *Lactobacillus kimchii*, *L. plantarum*, *L. pentosus*, *Lactococcus gelidum*, *Lactococcus lactis*, *Leuconostoc carnosum*, *Serratia marcescens*, *Weissella cibaria*, *W. confusa* etc.

The first step in the making of any Kimchi is to slice the cabbage or daikon into smaller, uniform pieces to increase the surface area. The pieces are then coated as

a preservative method, as this draws out the water to lower the free water activity. This inhibits the growth of undesirable microorganisms. The salting stage can use 5-7% salinity for 12 hours or 15% for 3-7 hours. The excess water is then drained away, and seasoning ingredients are added. The sugar that is sometimes added also acts to bind free water that still remains, further reducing free water activity. Finally the brined vegetables are placed in to an airtight canning jars and left to sit for 24-48 hrs at room temperature. The ideal salt concentration for the fermentation process is about 3% since the fermentation process results in the production of carbon dioxide, the jars should be "burped" daily to release the gas.

## **Bread**

The cereal grain most commonly used for making bread is wheat flour. Other grains used are rye, maize, but the use of its are limited. For the preparation of bread dough, the ingredients required are refined flour, water and yeast. Salt and fat are also used for dough making. Flour is the bulking ingredient of bread, it forms the structure of the product. It contains gluten. Gluten helps to form an elastic stretchy dough.

Yeast is a raising agent. Yeast produces gases to make the bread rise. Salt is used to bring out flavor in the bread. It must be used in small quantities. Too much of this will stop the yeast growth.

## **Starter culture**

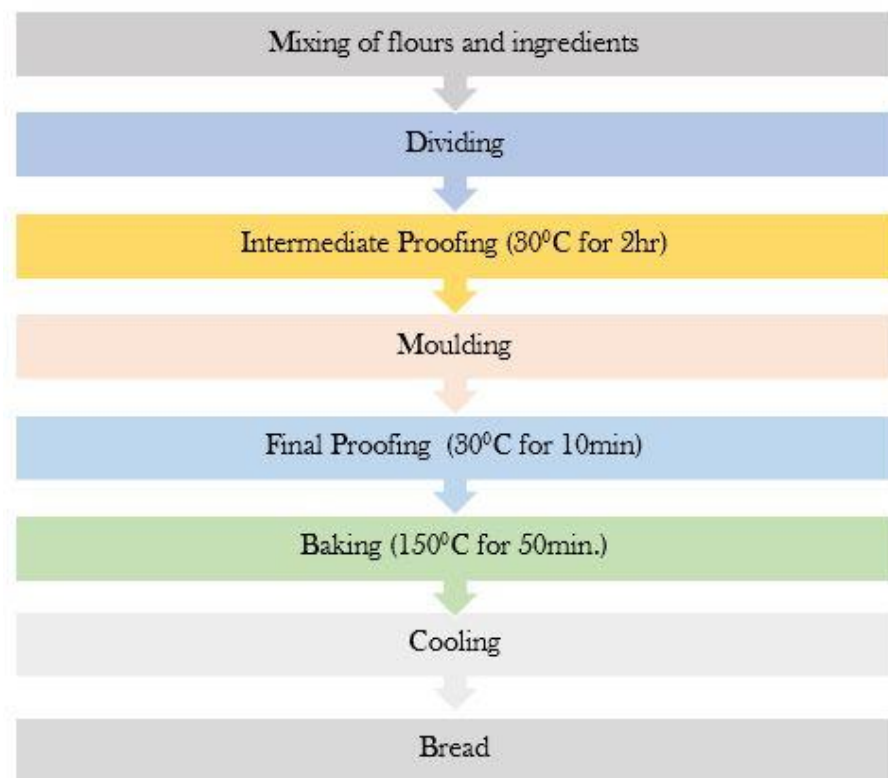
Baker's yeast is the common name for the strains of yeast commonly used as a leavening agent in baking bread and bakery products, where it converts the fermentable sugars present in the dough into carbon dioxide and ethanol. Baker's yeast is of the species *Saccharomyces cerevisiae*, which is commonly need in alcoholic fermentation and is called **brewer's yeast**.

**Leavening.** It is the production or incorporation of gases in the baked product to increase volume and to produce shape and texture.

## **Methods of bread making**

### **Straight dough method (Direct dough method)**

All the ingredients are mixed together and the dough is fermented for pre-determined time. The fermentation time of the straight dough depends on the strength of the flour. Strong flour requires more fermentation time to mature adequately. Flours which require 2 to 3 hours for maturing should be used for making bread by straight method. Flours that take very long period for maturing should not be used because during prolonged fermentation periods it is very difficult to control the temperature of the dough and rise in temperature will cause acid taste and favor in bread.



Flow chart for straight dough method of bread making.

### Sourdough method

Sourdough bread is made by the fermentation of dough using naturally occurring *Lactobacilli* and yeast. Sourdough bread has a more sour taste and better inherent keeping qualities than breads made with baker's yeast due to the lactic acid produced by the *Lactobacilli*. Sourdough is a dough containing a *Lactobacillus* culture in symbiotic combination with yeasts. Flour naturally contains a variety of yeasts and bacterial spores. When wheat flour comes into contact with water, the naturally occurring enzyme amylase breaks down the starch into the glucose and maltose, which sour dough's natural yeast can metabolize. The bacteria ferment starches that the yeast cannot metabolize and the by-products, chiefly maltose are metabolized by the yeast which produces carbon dioxide gas and leavening the dough. A satisfactory rise from sourdough takes longer time than a dough leavened with baker's yeast because the yeast in a sourdough is less vigorous. In the presence of lactic acid bacteria however some sourdough yeasts have been observed to produce twice the gas of baker's yeast. The acidic conditions in sourdough, along with the bacteria also producing enzymes that break down proteins, result in weaker gluten and may produce a denser finished

product.

### Sponge-dough method

The sponge-dough method is a two step bread making process. In the first step a sponge is made and allowed to ferment for a period of time and in the second step the sponge is added to the remaining dough's ingredients to form a final dough. In the first stage, a certain amount of flour (around 50-70% of total dough flour), water and yeast are mixed and fermented for a period of time (2.5-4.5 hours) to produce a sponge. In the second stage the sponge is added to the other remaining ingredients to form a final dough. The final dough can be processed by a rapid processing method involves kneading, rolling and moulding.

### Modified straight dough method

Modified straight dough method involves the following steps

- Dissolve the yeast in part of the water
- Combine the fat, sugar, salt, milk solids and flavorings
- Mix well, but do not whip
- Add eggs one at a time as they are absorbed into the mixture
- Add the rest of the liquids and mix briefly
- Add flour and the dissolved yeast last
- Mix until a smooth dough forms

The modified mixing method is basically for rich sweet dough. This is basically the modification of the straight dough method to ensure that the fat and sugar are evenly distributed in the dough. This method is very simple but requires a few more steps compared to straight dough method.

### No- time dough method

- Dough is fermented. It is allowed for a brief period (about 30 minutes).
- Since dough is not fermented the two functions of fermentation (production of gas and conditioning of gluten) are achieved to some extent by increasing the quantity of yeast (2-3 times of original quantity) and by making the dough little slacker and warmer.
- Although it is possible to make fairly acceptable bread during emergency by using this method the product has poor keeping quality. Due to the absence of fermentation, the gluten and starch are not conditioned sufficiently to retain the moisture.

### Delayed salt method

It is also referred to as the 'autolyse'. It is particularly useful when making

bread by hand, but commonly used when a mixer is employed. This method is very simple. Delayed salt allows natural or biological development of a part of the amino acids in gluten called cystein, to occur, which can't happen in the presence of salt.

This is a slight variation of straight method, where all the ingredients are mixed except salt and fat.

- As the salt has a controlling effect on enzymatic action on yeast, the speed of fermentation of a salt less dough will be faster, and a reduction in total fermentation time will be faster.
- The salt is added at a knock back stage. The method of adding salt at the later stage may be according to the convenience of individual baker. It may be sifted on the dough and mixed or it may be creamed with fat and salt.
- Whatever way is chosen for mixing the salt, only three-fourths mixing should be given initially and one-fourth mixing at the time of adding salt.

## **Biological leavening agent**

- *Saccharomyces cerevisiae*: - producing carbon dioxide
- *Clostridium perfringens*: - producing hydrogen found in salt-rising bread, which leavens dough the same way carbon dioxide from yeast does.

## **Chemical leavens**

Chemical leavens are mixtures or compounds that release gases when they react with each other, with moisture or with heat. Baking soda, bases, acids are used for chemical leavening in the baking industry. Bases such as sodium bicarbonate, ammonium bicarbonate and potassium bicarbonate and acids such as potassium acid tartrate, fumaric acid, sodium acid pyrophosphate, monocalcium phosphate, sodium aluminium phosphate, sodium aluminium sulfate, glucono delta-lactone etc are used as leavening chemicals.

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