**Fermented Foods: Soy Products**

Soybeans, in the form of soy sauce and soybean cheese, paste, sprouts, milk, and curd, have been an important source of protein in the diet for centuries.

**Soy sauce**: Soy sauce, shoyu in Japanese, is the most popular use made of the soybean. It is a dark-brown liquid, very salty and sharp in flavor. Soybean paste is a semisolid, mushy food. Its flavor is like that of soy sauce. It is used as a relish for rice, in soups, and to add flavor to vegetables. Soy sauce is manufactured by two basic processes. One involves a fermentation technique and the other a chemical method. A third procedure, which is thought to have some advantages, is a combination of the two. The third method is still in the developmental stage. The products of the different methods differ somewhat in taste and odor; the fermentation product is the most acceptable. Sometimes the products of two basic processes are blended. The fermentation method is a mixed fermentation by three micro-organisms: **A mold, *Aspergillus oryzae*; a bacterium, *Lactohacillus delbruckii*; and a yeast, *Zygosaccharomyces soja*, Z. major, or a yeast closely related to *Haiisenula anomala****.*

**The technique includes the use of pure culture inocula of all the micro-organisms needed in the fermentation.** The materials are soybeans, wheat or other starchy grains or flour, and salt.

* First, the beans are washed and then soaked in water for 12 to 24 hours, depending on the temperature. Longer soaking is needed in winter or when the temperature is low. The soaking finished, the beans are drained of excess water and cooked with steam under 10 pounds pressure. The cooking period covers several hours.
* The second step includes the addition of soft wheat, which has been cleaned, roasted, and cracked or very coarsely ground. It is mixed with the cooked soybeans in the ratio of about 3 pounds of wheat (initial weight) to 10 pounds of cooked soybeans (initial weight).
* In the third step, the mixture of beans and wheat is inoculated with a culture of one or more strains of the mold *Aspergillus oryzae*. The inoculation cultures are made by growing the mold on steamed polished rice. An ounce of rice will make enough koji to inoculate 10 pounds of the soybean parched wheat mash. In modern factories, cultures of the necessary yeast and bacteria are added at this point. A good yeast growth before the mold growth becomes apparent is believed to result in a sauce of superior quality.

After inoculation, the mash is spread in a layer 3 inches deep in wooden trays or baskets about 4 inches deep. The trays are stacked so that air will circulate freely over the beans. During the fermentation stage, the mold grows throughout the mash and gives off considerable heat. The temperature of the material may reach 40° C. (104° F.) or higher, if it is not controlled.

The beans are stirred daily for the first few weeks, then weekly until the end of the fermentation period. After 3 months preferably after a year or longer, the mash is pressed to remove the liquid. This is considered the best grade of soy sauce. The sauces are pasteurized at about 65° C. (149° F.). If higher pasteurization temperatures are used, a cloudy sauce results because of the precipitation of partly degraded proteins. Alum is then added as a flocculating agent, and the sauce is filtered.

**Role of ingredients used in preparation**:

1. Cloves, cinnamon, nutmegs, pepper, ginger, and other spices enhance the flavor and are believed to prevent spoilage.
2. Caramel may be added to darken the sauce.
3. Licorice or maltose may be added to sweeten it.
4. Wheat serves as a carbohydrate source for the growth of the micro-organisms.
5. The mold supplies the enzymes necessary to convert the starch to sugar, which, in turn, is acted upon by all three micro-organisms.
6. The mold and yeast produce some alcohol from the sugar.
7. The bacteria produce lactic acid and other organic acids.
8. Esters, such as ethyl acetate, are also formed by interaction of the alcohols and organic acid. They account for much of the aroma and flavor of the sauce.

**Miso** is the most important soybean food product of Japan. It is prepared in three varieties-white, red, and black. Soybeans, wheat or wheat flour, and rice are used to make white miso in the proportions of 2: 1: 1. The soy-beans arc soaked in water about 20hours, drained, and cooked for 2 hours in a pressure cooker under 10 pounds steam pressure. When wheat flour is used it is made into dough with water, and baker's yeast is added. The dough is allowed to rise for a day. It is then molded into loaves about 2 inches square, and steamed for 1 hour at atmospheric pressure. Polished rice is soaked 2 hours in water, drained, and steamed in a collander. The loaves of dough arc broken and mixed thoroughly with the steamed rice and soybeans. The mixtures is inoculated with a rice culture of soy-sauce mold, *Aspergillus oryzae*. Shallow pans arc filled with the paste to a depth of 2 inches, and left at room temperature until the surface is covered with a white mold growth. If the mold growth continues until green spores are formed, the miso will be of poor quality. The moldy paste is put in a deep vessel and salt is added. The fermentation time in the salt mash will vary from 1 to 4 weeks. At the end of the fermentation period, the mash is steamed and is ready for use without further treatment.

The salt content of miso is much lower than that of soy sauce. Consequently, miso is much more subject to spoilage by micro-organisms. The paste is usually consumed within a month or two after manufacture. Spices are commonly added to miso shortly before it is served.

**Soybean cheeses** are made by fermenting the curd obtained from soy-bean milk. To make the curd, the soy-beans are soaked in water 6 or 7 hours in summer, or up to 24 hours in winter. The raw, soaked beans are ground with cold water, and then pressed to remove the milk. The curd is usually precipitated from the milk, which has been heated almost to the boiling point, by the addition of calcium or magnesium sulfates. The curd is pressed to a consistency suitable for cutting into small cubes.

**Sufu** is a light-gray soft cheese made by the fermentation of cubes of curd 1 to 1/2 inches thick. The cubes are dipped in dry salt, placed in a shallow- pan, and inoculated with a culture of the mold *Mucor sujii*. After 3 days at a temperature of about 25° G. (77° F.), they are covered with a white mold growth, which turns gray by the fifth day as sporangia arc formed.