Lactic Acid Fermentation and Traditional Japanese Foods

Introduction

Fermented foods add complexity to our eating habits. Fermented foods are made from milk, vegetables, grains, and other foods, and their scents and tastes are modified by microbial fermentation. Lactic acid bacteria are involved in many kinds of fermented foods: yogurt, cheese, sour bread, pickles, alcoholic drinks, soy sauce, and miso. Yogurt and cheese are the first foods people think of when discussing foods made by lactic acid fermentation. According to records, people in Japan ate a dairy food similar to cheese during the Asuka and Nara eras more than 1300 years ago. It was called *daigo* and is considered to be a food like condensed milk or butter oil. When Buddhism, which forbids meat-eating, was introduced into Japan, people gradually gave up manufacturing these dairy products. Therefore, details of these foods in the literature are sketchy. In this issue, we introduce steeped foods as traditional Japanese fermented foods in which lactic acid fermentation plays an especially important role.

What are steeped foods?

Steeped foods are divided into two types, depending on whether or not fermentation by microorganisms is an essential part of the process. When fermentation is involved, foods such as vegetables, fruits, fishes, meats, etc. are pickled in salt, rice bran, sake lees, soy sauce, miso, vinegar, etc. When microorganisms are not involved, these foods are simply pickled in seasoning soup. Steeped foods have become an important element of many cultures such as in Korea (kimchi), China (zatsuai), Europe (pickles) and other countries **(Photo 1)**.

Nuka-miso pickles

Japanese steeped vegetables in which lactic acid fermentation plays an important role are summarized in **(Table 1)**.

Pickling vegetables in *kome-nuka* (rice bran powder produced from polishing brown rice) is unique to Japan. *Kome-nuka* kneaded with salt, malted rice, soybeans, sake lees, etc. is called *nuka-miso* or *nuka-doko*. Cucumbers, eggplants, turnips, and other vegetables pickled in *nuka-miso* are a favorite Japanese side dish.

Inside *nuka-miso*, lactococci such as the *Pediococcus* genus proliferate at the beginning of the fermentation. Thereafter, as acid concentration increases, lactobacilli such as *Lactobacillus plantarum* and *Lactobacillus brevis* predominate. Lactic acid produced by these bacteria prevents contamination and growth of other unwanted bacteria and adds a sour taste to the pickles. In addition, B vitamins and other nutrients diffuse from *kome-nuka* into *nuka-miso* and provide additional nutrients not contained in fresh vegetables. Also, *kome-nuka* proteins are degraded into amino acids and add various flavors and tastes to *nuka-miso* pickles.

Different methods of preparing *nuka-miso*, each with a different taste referred to as "mother's taste", have been handed down within individual households.

Photo 1 : A scene of steeped food shop

Table 1. Japanese steeped vegetables in which lactic acid fermentation is involved.

Steeped in	Name of food	Preparation
salt	takana-zuke, pickled plum, tsubo-zuke, kan-zuke, nozawana-zuke, pickled shallots, etc.	Vegetables are steeped in salt with other minor ingredients with or without pretreatment overnight or for several months.
kome-nuka	takuan-zuke, nuka-miso pickles, etc.	Vegetables are dried in the sun or salt and steeped in kome-nuka with other minor ingredients.
non-salt	goishicha, awabancha, sunki, etc.	Leaves are steeped after pretreatments with boiling and steaming for rigorous lactic acid fermentation.
others	suguki, etc.	Special pretreatment is necessary, followed by heating and maturing.

Source: Lactic acid bacteria: Secrets of fermented foods for good health by Michio Kozaki

Takuan

Takuan is made of white radish pickled in *kome-nuka* and became popular in Japan during the Edo era. Freshly cropped white radish contains more than 90% water, and it is necessary to reduce the water content before pickling in *kome-nuka*. Takuan is divided into two types depending on the method used to reduce the water content: dried *takuan* and salt-pressed *takuan*. The manufacturing process is illustrated in **(Figure 1)**. *Takuan* is prepared by washing radishes; drying them in the sun to remove water **(Photo 2)**; steeping them in a large amount of salt (rough pickling), then in a small amount of salt (intermediate pickling); and finally steeping them finally in *kome-nuka*, salt, and seasonings (final pickling). Lactic acid bacteria appear during the process of rough pickling and then grow during the intermediate and final pickling processes. They add a specific sour taste and flavor to *takuan*. Since drying in the sun depends on the weather, it is not appropriate for mass production at a factory. In contrast, salt-pressing, a method to remove water from radishes by steeping them in salt, does not depend on the weather.

Steeped tea leaves

Teas are classified as green tea, oolong tea or black tea depending on how soon after picking the enzymes in the leaves are inactivated by heating. The three kinds of tea are called non-fermented tea, partially fermented tea and fermented tea, respectively. Fermentation in this case is performed by the enzymes in tea leaves and differs from that performed by microorganisms.

Special types of non-fermented tea like (*awabancha* in Tokushima) involve lactic acid fermentation. This type of tea is characterized by its sour taste. To prepare *awabancha*, the tea leaves are boiled and the broth is saved for later use, and the then leaves are placed in a tea roller to damage them mechanically. The damaged leaves and the broth are stuffed into a barrel, and a heavy stone is placed on the top of the cover to press the leaves. Thereafter, the leaves are dried in the sun.

A steeping process called "*akutai*" is commonly included in preparing the above kinds of tea; when this is included, these special types of tea are also called pickled tea leaves. *Akutai* provides an important place for lactic acid fermentation, which adds a sour taste and flavor to steeped tea leaves. *Lactobacillus plantarum* is among the primary lactic acid bacteria that grow during steeping process.

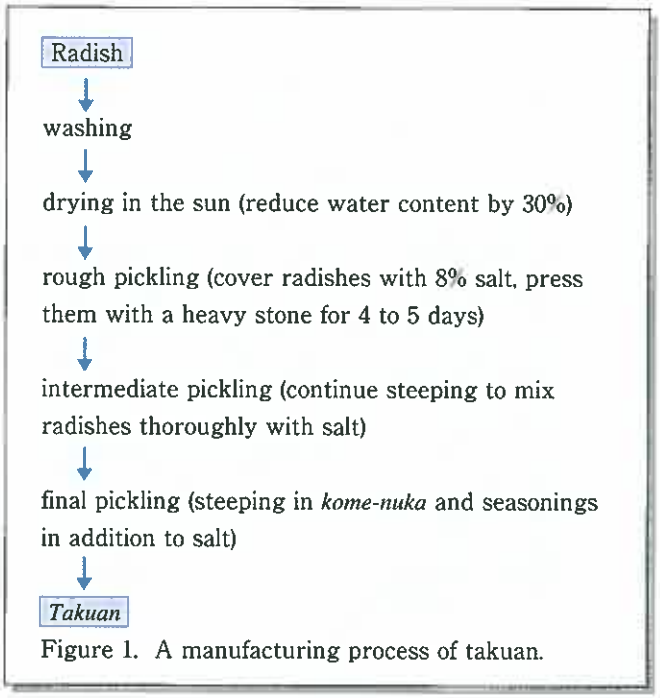

Figure 1. A manufacturing process of takuan.

Photo 2 : Drying of white radish in the sun.

Steeped fishes

Japanese steeped fishes in which lactic acid fermentation plays an important role are summarized in **(Table 2)**. These foods are prepared by steeping salt-embedded fishes with steamed rice or *kome-nuka*. The specific flavor that characterizes steeped fishes comes from lactic acid fermentation during the process of steeping fishes with steamed rice. Preparation of steeped fishes is characterized by its long period of rice steeping ranging from 4 months to 2 years. During this process, organic acids such as lactic acid, acetic acid, isovalerian acid, propionic acid and butylic acid, and extracts obtained from microbial fermentation and by autodigestion of fish meat are produced which create the flavor and sour taste specific to steeped fishes.

Concluding remarks

Lactic acid can guarantee better preservation of fermented foods in addition to better flavor. Lactic acid bacteria have been used as a medicinal preparation for controlling intestinal function. Lactic acid obtained by lactic acid fermentation is now being used as a raw material to develop polylactate, which has been familiar to us from antiquity, provides us with an enriched and healthy diet and may offer in the future the possibility for novel applications in new fields.

Table 2 . Japanese steeped fishes in which lactic acid fermentation is involved.

Name of food	Species of fish	Preparation
funa-zushi	crucian	Fishes are steeped in salt, then with steamed rice for more than 4 months.
nare-zushi	mackerel, saury, spotted shad, sweetfish, etc.	Fishes are steeped in salt, then with steamed rice for 7 to 10 days. Different fishes are used in different districts.
i-zushi	salmon, herring, trout, sandfish, etc.	Fishes are steeped in salt, then with steamed rice, malted rice, sake, and sweet sake seasoning. Vegetables such as carrot, cucumber, and ginger and seaweeds such as agar-agar and sea tangle are added. They are sometimes steeped with herring roe and salmon roe.
heshiko	sardine mackerel	Fishes are steeped in salt, then with kome-nuka and malted rice.
nuka-zuke	herring puffer fish	Fishes are steeped in salt, then with kome-nuka and malted rice.
	puffer fish ovary	Ovaries are steeped in salt for more than 2 years, then with kome-nuka for more than 1 year. The ovary contains tetrodotoxin, but finished products can be eaten.