# Outline of sake brewing

## Learning outcomes

- Outline knowledge of how to make sake. See Chapter 8 for details of differences among types.
- Knowledge of *koji* and its role
- Knowledge of *shubo/moto* (seed mash) and its role

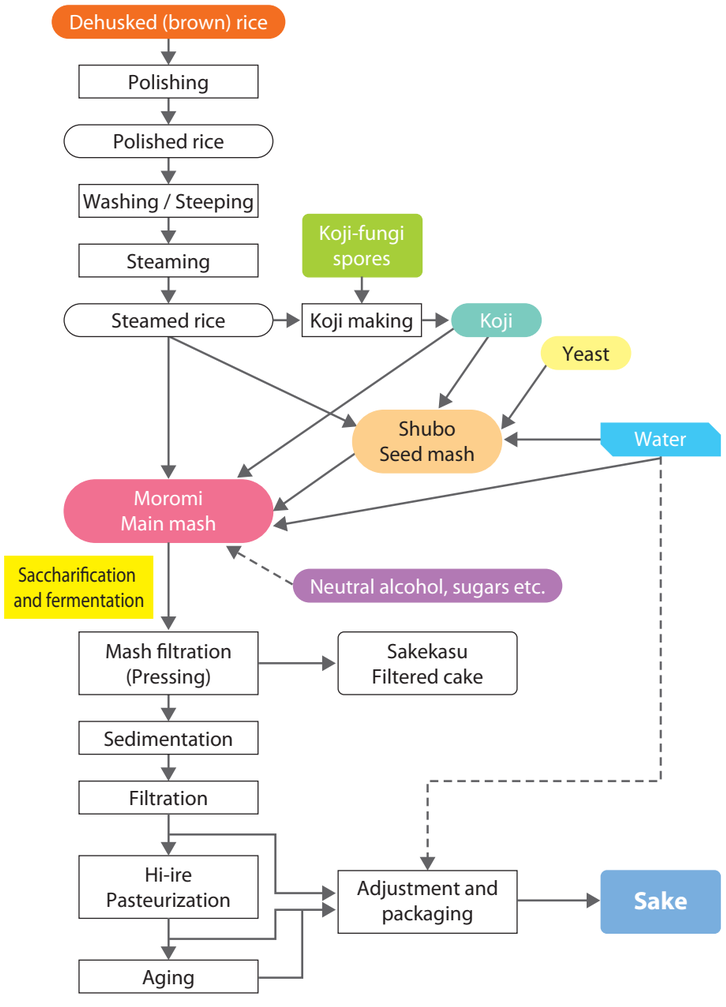



**Figure 2.1 Outline of sake-brewing process**

## 2.1 Rice

There are broadly two varieties of rice: indica, a long-grained variety, and japonica, a short-grained variety. Each of these can further be subdivided into sticky and non-sticky rice. Non-sticky japonica rice grown in Japan is used to brew sake in Japan. This is the same type of rice that Japanese people normally consume as food. Many types of premium sake are made with sake rice, which is especially suited to sake brewing. Features of sake rice are large grains, low protein content, and high solubility during the brewing process (Sec. 8.1).

## 2.2 Water

Japan receives abundant rainfall. Forests occupy 60% of the land surface and water is plentiful. Historically, sake makers erected breweries in locations with access to good-quality water.

The water used to make sake must comply with standards applying to water for use in the manufacture of food products. Importantly, it must contain no more than 0.02 ppm of iron. Too much iron gives sake a reddish-brown color and spoils the aroma and taste.

## 2.3 Rice polishing (milling)

The outer layers of unpolished rice contain large amounts of fats, minerals and proteins that spoil the flavor of sake, therefore the rice is polished using a high-speed rotating roller (Fig. 2.2). Normally, the outer 30% of the grain is removed, leaving the central 70%. This polished rice is known as 70%-polished rice or is said to have a *seimai-buai* (polishing ratio) of 70%. For ginjo-shu, the outer 40% or more of the grain may be removed (Fig. 8.3).

## 2.4 Washing, steeping and steaming

After milling, the polished rice is washed in water to remove the bran and is left to steep in water. When the grain has absorbed 30% of its weight in water, it is removed from the water and steamed for about one hour. Steamed rice is less moist and sticky than boiled rice, making it ideal for use in sake production.

**Figure 2.2 Rice milling machine**

## 2.5 Kome-koji (Koji rice) making

Grape juice contains sugars, which ferment in the presence of yeast, but with beverages made from grains, such as sake and beer, it is first necessary to use enzymes to break down the starch in the grain to convert it to sugar before yeast fermentation. The enzymes play a number of roles, finely shredding the starch to convert it into sugar, breaking down protein, and producing peptides and amino acids.

In beer brewing, malt is used as the source of these enzymes, but for making sake, a substance called kome-koji (koji rice) is used (Fig. 2.3). Koji rice is made by cultivating koji-fungi on steamed rice. Koji rice may simply be called koji. The koji-

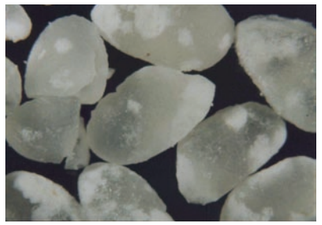
**Figure 2.3 Koji making**

fungus (*Aspergillus oryzae*) is a beneficial and safe variety of mold that is also used in the production of traditional Japanese seasonings, such as miso and soy sauce.

The first step in making the koji for use in sake brewing is to inoculate steamed rice with the spores of koji-fungi, called *tane-koji*. After a while, the spores germinate and start to spread their fungal filaments. In about two days, the steamed rice is entirely covered with koji-fungi. As the koji-fungi grow, they produce enzymes, which accumulate within the koji (Fig. 2.4).

Koji-fungi are most active at a temperature of around 36°C, but cease all activity at a temperature above 45°C. For this reason, the process is carefully controlled in a room in the brewery called a *koji-muro*, where the temperature is kept at around 30°C and the relative humidity maintained in the range of 50%–80%.

The polished rice to make koji is called koji-mai. Koji enzymes are highly efficient and the ratio of koji-mai in the polished rice used to make sake only has to be in the 15%–25% range for the enzymes to perform their role.



After 20 hours

after 44 hours (completion)

**Figure 2.4 Changes during koji manufacturing process**

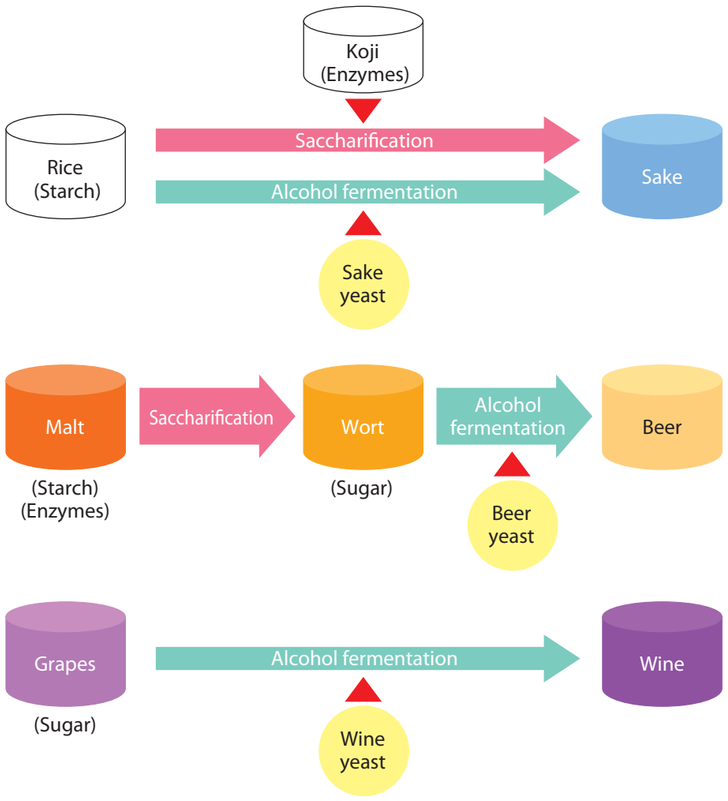



**Figure 2.5 Differences in fermenting methods for sake, beer and wine**

## 2.6 Yeast and seed mash

Top-grade yeast specifically intended for sake brewing is selected for the fermentation process.

Before the main fermentation, the brewer first prepares seed mash, called *shubo* or *moto*, by significantly increasing the amount of top-grade yeast. This is used as a starter for fermentation of the main mash. The word "shubo" means "mother of sake," while the word "moto" means "base" or "source."

It is important for shubo to be highly acidic in addition to containing top-grade yeast. Fermenting in acidic conditions suppresses the microbes that spoil sake, but unlike grapes, rice itself contains no acid. That is why strongly acidic shubo must be used. Methods of producing highly acidic shubo include use of lactic acid bacilli and use of brewing-grade lactic acid. The details of this are discussed in Chapter 8.

## 2.7 Main mash and fermentation

The standard ratios of steamed rice, koji and water placed in the fermentation tank are steamed rice 80, koji 20 (expressed as ratios of polished rice) and water 130. The total amount of rice placed in a single fermentation tank ranges from less than one metric ton (mt) to more than 10 mt. It is not all added at once, but in three steps over four days. On the first day, the amount of steamed rice and koji placed in the tank is equal to one-sixth of the total. Seed mash (shubo) is also added on this first day. Nothing is added on the second day, giving the yeast time to multiply. On the third day, an amount equal to two-sixths of the total is

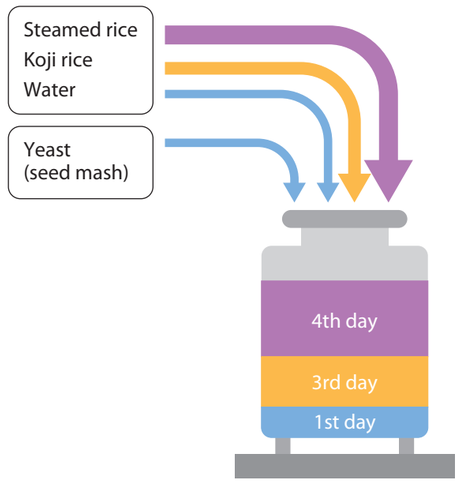



**Figure 2.6 Three-stage mashing process**

placed in the tank, with the remaining three-sixths added on the fourth day. The temperature of the mix in the first step is 12°C, but this is gradually lowered to 10°C at the second step and 8°C at the third step.

If the entire amount were added to the tank at once, the yeast would become too diluted, prolonging the time required to reach the right density for the proper fermentation of alcohol and allowing microbes to multiply, which could abort the fermentation process and spoil the mixture. That is why the process is carried out in the steps described above.

In the sake *moromi* (main mash), the enzymes in koji dissolve the steamed rice and the yeast ferments the resulting sugars simultaneously in a single tank. The fermentation temperature is usually in the range of 8°–18°C. The fermentation process takes around three to four weeks, yielding an alcohol content of around 17%–20%.

Using a lower fermentation temperature of 12°C or less prolongs the fermentation time to around four to five weeks. Under these conditions, the action of the yeast and the process of dissolving the rice are retarded, reducing the acidity and resulting in sake with a highly fruity aroma and clean taste.

## 2.8 Mash filtration (pressing)

When the fermentation is complete, the moromi is filtered with cloth and the undissolved rice and yeast removed, leaving the new sake. This process may be done by placing the moromi in a cloth bag and using a machine to apply pressure from above or by using a horizontal machine similar to a beer mash filter press.

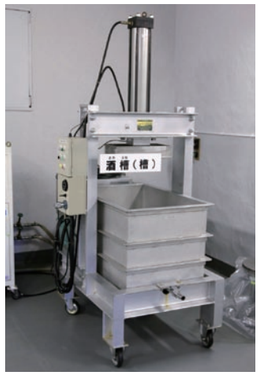



**Figure 2.8 Mash filtration machines**

The cake left over from the process is called *sakekasu* (filtered sake cake). In addition to undissolved rice and yeast, it contains about 8% alcohol by weight. Sakekasu is highly nutritious and can be eaten as is or used as a raw ingredient for making shochu—traditional Japanese distilled liquor—or for pickling vegetables.

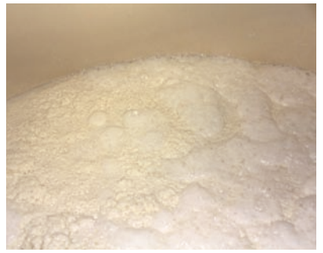


**Figure 2.7**
**Moromi during fermentation**

## 2.9 Sedimentation and filtration

With the initial filtration, some turbidity remains. If the liquid is left to stand at a low temperature, this precipitates out as sediment and the clear part is transferred to another tank.

It is then filtered to produce a clear liquid. However, sake that has been filtered to make it clear may lose its transparency during storage. This is due to changes in the proteins dissolved in the sake, causing them to become insoluble. The use of persimmon tannin or colloidal silica is approved for removing the proteins that cause this cloudy appearance.

Use of active charcoal is also approved for decoloring, flavor adjustment and control of the aging process (by removing substances that cause coloring and flavor changes).

## 2.10 Pasteurization

After sedimentation and filtering, most sake undergoes pasteurization (*hi-ire*) at a temperature of 60°–65°C before storing. The purpose of pasteurization is to sterilize the liquid and at the same time to render any enzymes inactive. If the action of enzymes is allowed to continue, it increases the sweetness through the action of diastatic enzymes and alters the aroma through the action of oxidizing enzymes. Many sake products are pasteurized again during bottling.

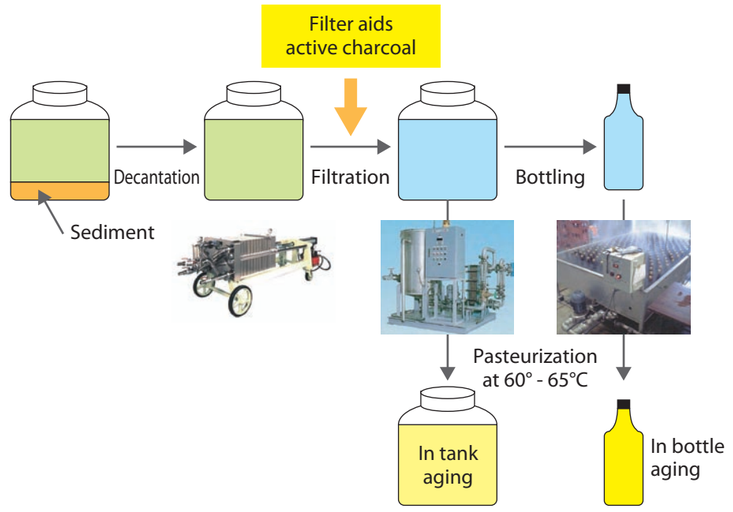



**Figure 2.9 Sedimentation, filtration, pasteurization and aging**

## 2.11 Aging (maturation)

The heating of sake during the pasteurization process alters the aroma and leaves it with an unrefined taste. For this reason, it is allowed to age for six months to one year. Many sake products are brewed between autumn and winter following the harvesting of the rice, allowed to age during spring and summer and then shipped the following autumn.

## 2.12 Adjustment and packaging

The alcoholic content of sake aged in tanks is 17%–20%, the same as at the mash filtration stage. As this level is too high for consumption with meals, brewers often add water to reduce the level to around 15% before bottling. They may also filter and pasteurize it again, if necessary.