Factors influencing types and varieties

Learning outcomes

More in-depth knowledge of factors influencing types and varieties of sake, as outlined in Chapter 2.
- Sake rice varieties
- Seimai-buai (polishing ratio) and reasons for lowering seimai-buai
- Koji making
- Types of yeast, process for making shubo (seed mash)
- Making ginjo-shu
- Mash filtration (pressing)
- Regional characteristics

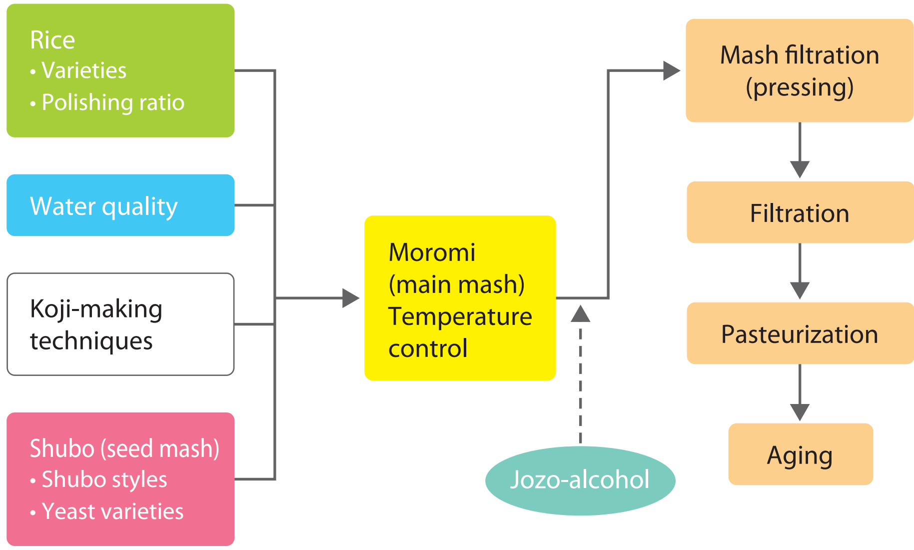

Figure 8.1 Factors influencing types and varieties

8.1 Rice

8.1.1 Rice varieties

Roughly 270 varieties of Japonica rice are grown in Japan. These include certain varieties, known as sake rice, which are suitable for use in sake brewing. Sake rice grains are large and have a white core (*shinpaku*, the white, opaque section at the center of the rice kernel formed by a matrix of starch granules pocked with voids) as well as a low protein content. The term "large grain" denotes any rice weighing 26 g or more per 1,000 grains of rice (Fig. 8.2). To be suitable for use in sake brewing, rice should be water absorbent, resilient when steamed and, owing to its ample shinpaku at the core, easy to turn into koji. It should also be readily soluble in moromi (main mash), and contain little protein, which can result in zatsumi (unrefined taste) if too plentiful. Sake rice has all of these characteristics. Solubility levels and other features of sake rice differ by variety, and these differences are reflected in the flavor characteristics of sake. The price of sake rice is on average more than 20% higher than that of table rice.

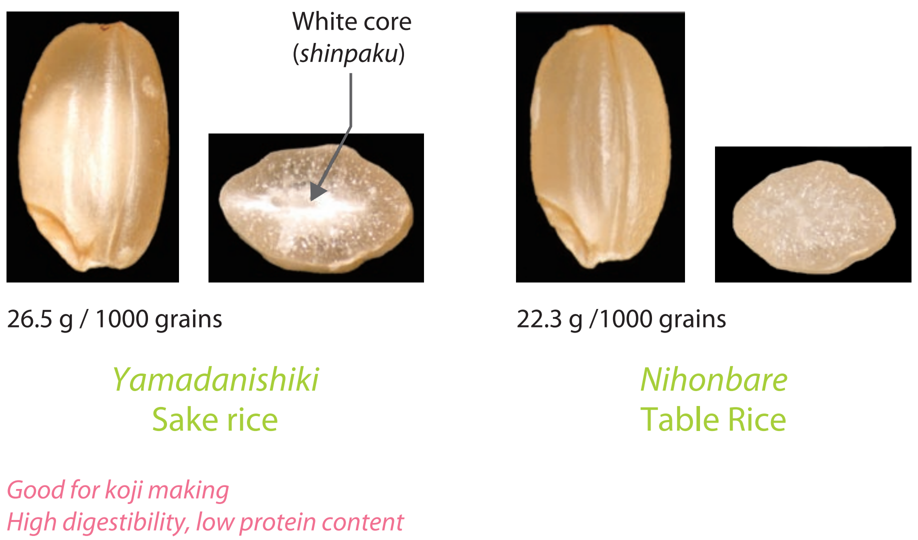

Figure 8.2 Sake rice and table rice

In Japan, each region has its own designated varieties of sake rice. Well-known varieties include Yamadanishiki, Gohyakumangoku, Miyamanishiki, and Omachi. More recently, new varieties have been developed, including Senbonnishiki (Hiroshima), Koshitanrei (Niigata) and Akitasakekomachi (Akita). In 2010, 95 varieties of sake rice were grown (Appendix I). Improvements in sake rice are made using sibling cross techniques.

Certain varieties that are mainly grown as table rice are also used. In 2008, a total of 180,000 tons of polished rice were used in sake brewing, of which sake rice accounted for 44,000 tons.

8.1.2 Seimai-buai (polishing ratio)

The main component of the rice grain is starch, but apart from this, the outer layers and germ of unpolished rice contain many nutrients, such as protein, fats, minerals, and vitamins. These nutrients are important for the proliferation of koji-fungi and yeast, but an overabundance speeds up the fermentation process causing imbalanced fermentation, which is detrimental to the color, aroma, and taste of sake. For this reason, not only is the germ removed, but also the outer layers of the unpolished rice in order reduce the levels of protein, fat, minerals, and vitamins. This is referred to as polishing or milling, but the amount of material removed is much greater than with polished rice for table use (Fig. 8.3).

The term seimai-buai provides an indication of how much the grain has been polished.

To be more precise, seimai-buai refers to the weight of the polished grain as a percentage of the weight of the original unpolished grain. For example, in polished rice for table use, the germ and bran, representing 8% by weight of the unpolished rice, are removed (resulting in a seimai-buai of 92%), but with rice used in sake brewing, between 30% and 70% of the outer layer is removed (resulting in a seimai-buai of 70%–30%). The lower the seimai-buai figure, the higher the cost of producing the sake, but the result is well-balanced sake with a pronounced aroma, smooth mouthfeel and good aftertaste.

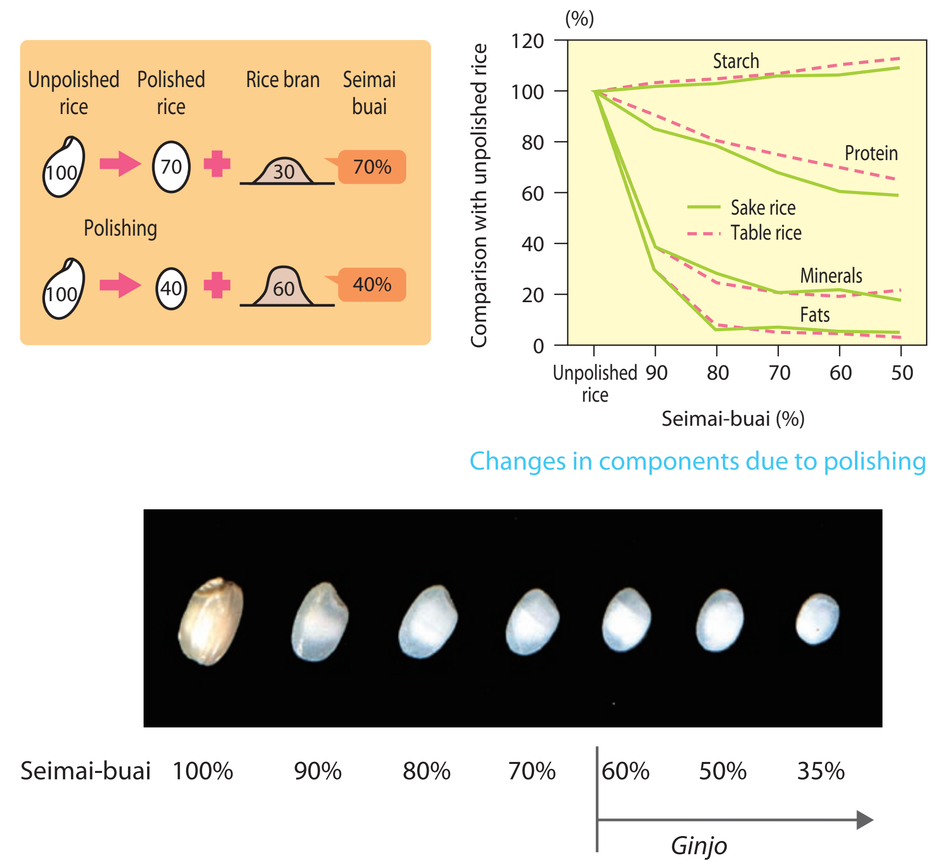

Figure 8.3 Seimai-buai and changes in components

8.1.3 Impact of weather during rice cultivation

Not surprisingly, the weather can affect the amount of rice harvested from fields. In years when temperatures are low and there is insufficient sunlight at the time of panicle and grain formation, the rice grains that form are smaller in size and more soluble, resulting in heavier-tasting sake than normal. In years when the weather is too hot, by contrast, the starch acquires a less soluble structure. This reduces the amount of rice that dissolves during brewing, resulting in weaker-tasting sake.

8.2 Water

Most water in Japan is soft water, the total hardness expressed in calcium carbonate equivalent is less than 60 mg/liter, but in some areas the water is much harder. For example, in the Nada district near Kobe, there is an area of hard water with a calcium carbonate equivalent of 150 mg/liter. Calcium stimulates the production and extraction of enzymes. Other minerals in hard water, such as potassium, magnesium and phosphates, assist the fermentation process by promoting proliferation of koji-fungi and yeast. For this reason, sake produced in areas where the water is hard tends to have plenty of body and a dry taste with a good finish.

8.3 Koji making

Unlike beer malt, koji is not produced in factories exclusively designed for that purpose. Each brewery makes its own koji. Koji making is the process that most exercises the mind of the *toji* (brewmaster), who oversees production at the brewery.

Broadly speaking, koji styles can be divided into *sohaze* and *tsukihaze* (Fig. 8.4). In sohaze, the koji-fungi covers the entire rice grain sending many hyphae, or strands, growing into the kernel. In this style, the koji has strong enzymatic activity and the koji is rich in vitamins produced by the koji-fungi. Koji made according to the sohaze style dissolves the rice well and promotes strong fermentation, resulting in sake with plenty of body. It is used to produce full-bodied sake and futsu-shu (regular sake) to which alcohol is added.

In the tsukihaze style, the koji-fungi grows in a spotted pattern over the rice grain. A cross section of the grain will show places where well-developed hyphae have grown into the grain and others where there are no hyphae. This still ensures appropriate enzymatic activity, but the vitamin and fatty acid content is lower. Sake made with this type of koji has a lighter taste than sohaze sake. Ginjo-shu, in particular, must be produced using the tsukihaze style. The toji carefully controls the amount of koji-fungi spores used, the quantity of water and the temperature to produce koji exhibiting these different characteristics.

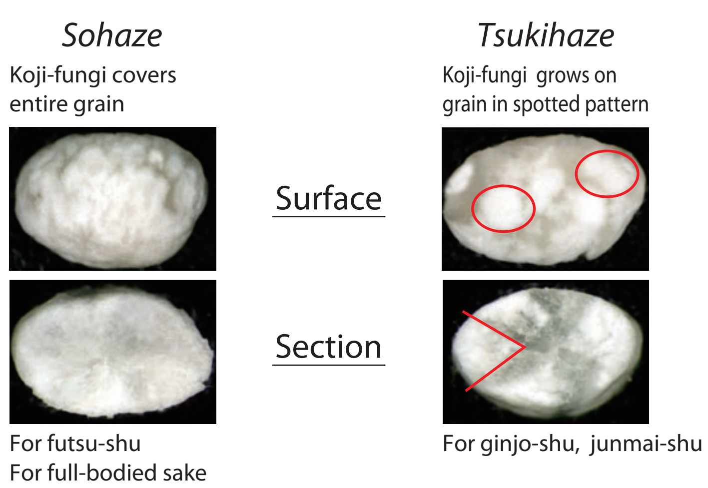

Figure 8.4 Koji styles

8.4 Yeast and shubo

8.4.1 Types of yeast

Yeast plays a critical role in determining sake quality. The practice of purely isolating and selecting yeast from the moromi of a brewery that produces good sake has a long history. Since 1906, yeast selected in this manner has been distributed by the Brewing Society of Japan as *Kyokai-kobo* (Brewing Society yeast). Kyokai-kobo is numbered, and currently, the most widely used yeasts are #6, #7, #9 and #10. Each produces its own aroma and taste characteristics and the specific choice depends on the desired sake quality. More recently, brewers have been utilizing microbial technology to produce yeasts designed to increase the amount of esters delivering a fruity aroma.

Table 8.1 Sake yeast varieties

Number	Source	Characteristics
6	Aramasa shuzo (Akita), 1935	Strong fermentation, mellow flavor, suitable for creating light taste
7	Miyasaka jozo (Nagano), 1946	Vivacious flavor, suitable for ginjo and futsu-shu
9	Kumamoto-ken shuzo kenkyujo (Kumamoto), 1953	Vivacious flavor and characteristic aroma of ginjo
10	Tohoku area, 1952	Low acidity and characteristic aroma of ginjo
14	Hokuriku area, 1991	Low acidity, suitable for producing ginjo
601-1401	#6, #7, #9, #10, #14	Non-foaming yeast strains
1501	Akita, 1990	Low acidity and characteristic aroma of ginjo
1801	Breeding, 2006	Low acidity and notably fruity aroma of ginjo

8.4.2 Shubo production process

Shubo production processes can be divided basically into those that use lactic acid bacilli to create the required lactic acid for the seed mash, and processes that add brewing grade lactic acid (90% solution) directly to the seed mash. The processes that use lactic acid bacilli are called *kimoto* and *yamahaimoto*. The best-known process that adds lactic acid directly is called *sokujomoto*.

In kimoto and yamahaimoto, only steamed rice, koji and water are mixed at about 8°C. The temperature is gradually raised and the amount of lactic acid bacilli increased. About two weeks later, once enough acid has formed, the yeast is added. As the temperature is further raised slowly to around 22°C, the formation of alcohol and the increased acidity of the mix kill the lactic acid bacilli, and only the yeast proliferates. It takes a month to make shubo using this method. The length and complexity of the yamahaimoto and kimoto process led a brewing scientist to develop the sokujomoto process, in which lactic acid itself is added seed mash, which eliminates the need to grow a lactic acid bacilli culture and reduces the shubo preparation time by about two weeks. The sokujomoto process is now the most widely used. Sake made with the yamahaimoto and kimoto processes tends to have more complex flavor than sake made with sokujomoto, because these two processes involve the use of complex microbial interactions rather than the simple addition of pure lactic acid. The resulting sake is said to be rich in peptides. (Fig. 8.5)

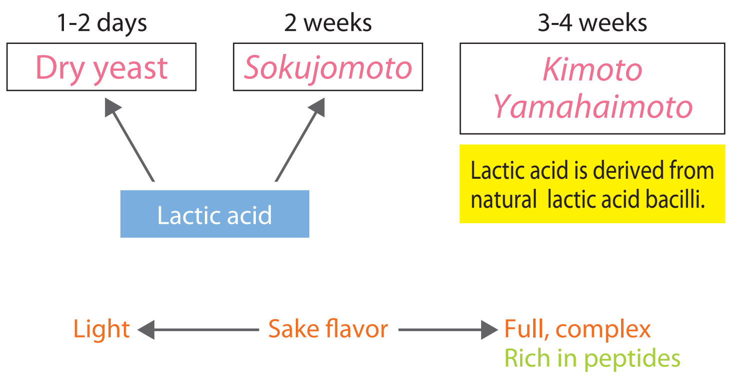

Figure 8.5 Shubo styles

8.5 Ginjo-zukuri

The keys to making ginjo-shu with a pronounced aroma and light taste are as follows and as shown in Figure 8.6:

(1) Use of good-quality ingredients: Preferably sake rice. This facilitates ginjo-koji making. The rice is readily soluble even at low temperature.
(2) Low seimai-buai: This is to reduce the amount of fat, which inhibits the formation of fruity esters. Reducing the protein content produces a light taste. It also suppresses yeast activity, thereby reducing the acidity.
(3) Ginjo-koji making: The tsukihaze style with low seimai-buai rice is used to make koji with an appropriate enzyme balance.
(4) Low-temperature fermentation: This suppresses yeast activity, reducing the acidity. The activity of aroma-producing enzymes is maintained, preventing aroma loss. Because less rice is dissolved, the taste does not become too heavy.
(5) Moderate pressing during mash filtration: Limiting the amount of pressure used in mash filtration results in a lighter taste. A similarity can be drawn with free-run wine.

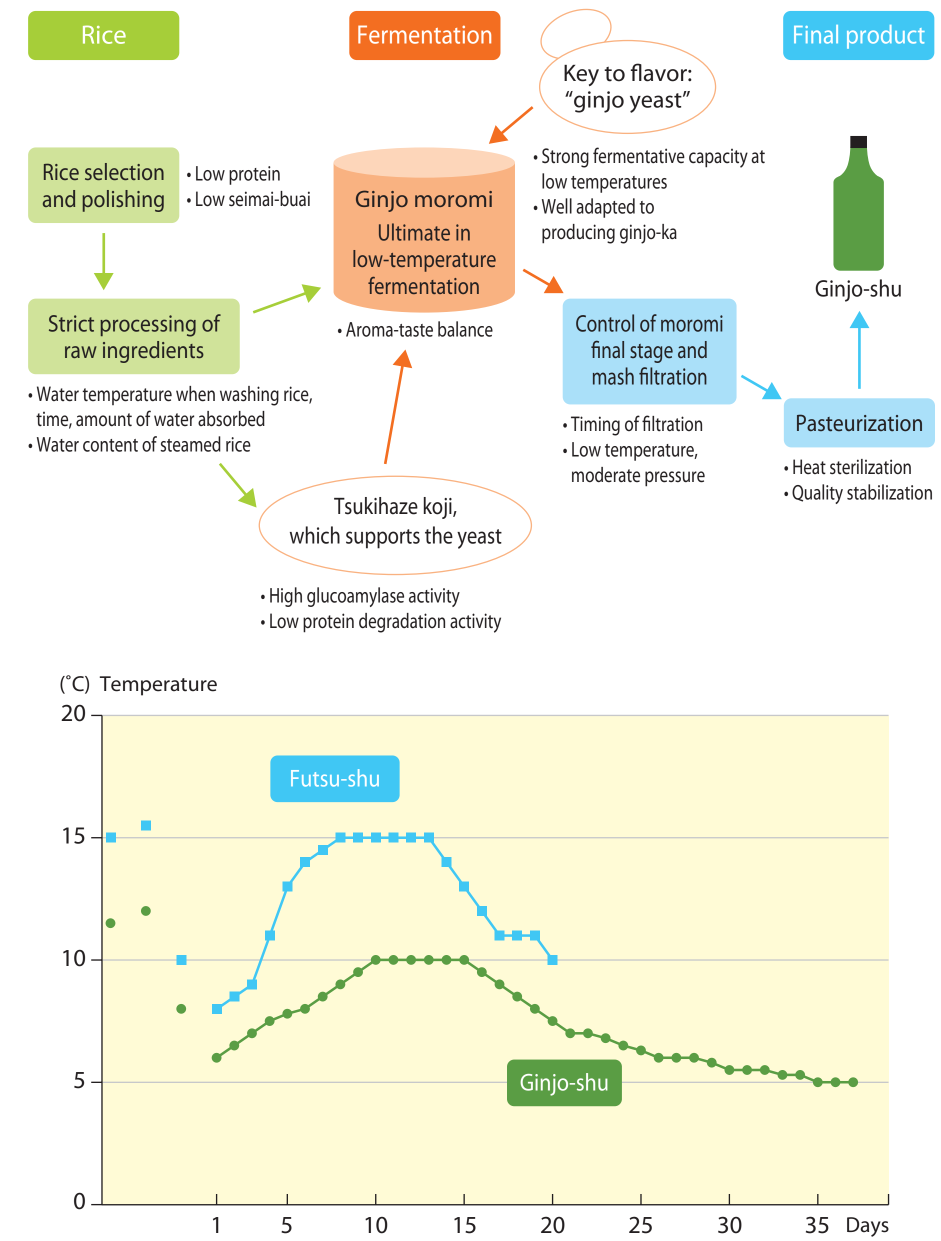

Figure 8.6 Ginjo techniques

8.6 Use of jozo-alcohol and other ingredients

Regulations allow for the use of "jozo-alcohol" made from molasses and grains, in ginjo-shu, honjozo-shu and futsu-shu. Alcohol equivalent in weight to less than 10% of the rice content may be added to moromi used in making ginjo-shu and honjozo-shu. Normally alcohol with a concentration of 30% is used. Adding alcohol extracts aroma ingredients, especially esters. At the same time, it dilutes ingredients derived from rice and fermentation, reducing acidity and umami to give the sake a light taste.

In addition to jozo-alcohol, items that may be added to futsu-shu are shochu, sugars, organic acids, amino-acid salts, sake, and sakekasu. The maximum amount of these items that can be added is less than 50% of the rice used by weight. The label must state when jozo-alcohol or other ingredients have been used.

8.7 Mash filtration (pressing), secondary filtration

Once fermentation is finished, the moromi is squeezed to separate the sake from the cake. The first sake released is slightly cloudy, but after this, the sake turns clear. The slightly cloudy sake that first emerges is called *arabashiri* (first run). The sake next released, without applying pressure, is called *nakagumi* or *nakadare*, and this is the best-quality sake. The sake released at the end of the process after applying heavy pressure has a more bitter or astringent taste.

Some brewer fill sacks with moromi and suspend them to allow the sake to drip down. This is designed to extract the sake without applying pressure. Sake obtained in this manner is called *fukurodori* (sack-drip sake or *shizuku sake*) (Fig. 8.7). Centrifugal separation is also used at some breweries.

The term *muroka* means no-filtration, but at the time of pressing, a cloth filter is used to separate the sake from the cake, so some form of filtration does in fact occur. Each brewer has its own idea about what muroka stands for. It can refer to sake that does not undergo secondary filtration or it can refer to sake that is filtered without using active charcoal. Sake labeled muroka is considered to have a richer flavor because it contains fine particles as well as the aromas and flavors that are removed when active charcoal is used.

Figure 8.7
Sake dripping from filter bags

8.8 Pasteurization

As explained in Section 2.9, apart from sterilization, the purpose of pasteurization is to stabilize quality by halting the action of enzymes. However, some of the freshness of freshly brewed sake is inevitably lost due to pasteurization. In recent years, advances in filtering technology and greater use of refrigerated storage and transportation have led to the marketing of a growing range of unpasteurized namazake products relying on cold storage and transportation systems. Microfiltering is often used to remove microorganisms from namazake.

8.9 Storage period and environment

8.9.1 Aging of namazake

Sake sold as namazake is kept at or below 5°C. It is stored for six months after production and is consumed in the spring to summer months. Prolonged storage results in a strong, nutty aroma reminiscent of hazelnuts due to the enzymatic oxidation. It also gives the taste a less rough or astringent quality and boosts the sweetness, umami and body.

8.9.2 Post-pasteurization aging

Pasteurization deactivates the enzymes and kills the yeast and other microorganisms, so the only changes that occur after pasteurization are physical and chemical.

Some breweries store ginjo-shu and similar varieties below 10°C, but normally the sake is stored at room temperature. Sake brewed in the winter is stored over the summer before shipping starts in the autumn, so it is consumed about one year after production.

Sake kept in long-term storage undergoes color changes due to the Maillard reaction between amino acids and sugars. There is also a decline in the fruity aroma that derives from esters and the aroma takes on a sweet, burnt quality. Sake aged for several years or several decades turns an amber or dark amber color and the aroma becomes more complex, resembling that of soy sauce, dried fruits or nuts. In some cases, it may develop a sulfury aroma similar to rotten cabbage or gas. While the taste loses its astringency and sharpness, it becomes more complex and bitter. Temperature and oxygen accelerate these reactions.

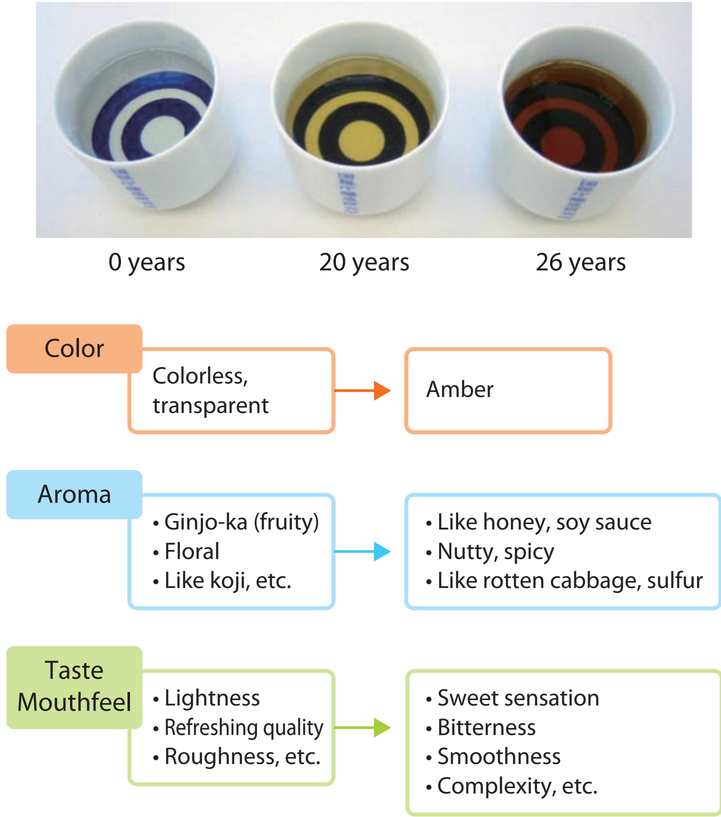

Figure 8.8 Changes during aging

8.10 Regional characteristics

Factors that determine the regional characteristics of sake are differences in rice, water, environment, local taste preferences and sake-brewing techniques.

Rice: No single variety of rice is grown everywhere throughout Japan. Different regions are suited for production of different varieties of rice (Appendix I).

Water: Most water in Japan is soft water, but there are a few areas where the water is hard. Dry sake evocative of hard water is produced in these areas.

Environment: Areas facing the Sea of Japan, such as Niigata, Yamagata and Akita prefectures, receive plentiful snow in winter and are blessed with stable low temperatures and a clean environment, conditions that are conducive to production of sake with a clean, delicate taste.

Local taste preferences: People living in the Kyushu area like food with a mildly sweet flavor, and this area appears to produce many sweeter-tasting sake products. In inland areas and those that receive plenty of snow, the people have historically had to use salt to preserve food. This has also resulted in a preference for sweeter-tasting sake varieties in these areas.

Sake-brewing techniques: Modern sake-brewing techniques derive from techniques developed in the Nada and Itami areas during the 19th century (Sec. 10.3). As these techniques spread to other areas, local variations matched to the rice, water, environment and local taste preferences of each region emerged. These techniques have been handed down by regional brewing guilds (Sec. 9.3), giving rise to the regional characteristics we see today.

Table 8.2 Average temperature, sunshine, precipitation of major cities

Average temperature (°C)

	Akita	Niigata	Tokyo	Fushimi (Kyoto)	Nada (Kobe)	Saijo (Higashihiroshima)
January	-0.1	2.6	5.8	4.6	5.7	2.0
February	0.2	2.5	6.1	4.8	5.8	2.5
March	3.2	5.4	8.9	8.1	8.9	6.1
April	9.2	11.2	14.4	14.1	14.7	11.7
May	14.2	16.1	18.7	18.8	19.2	16.5
June	18.8	20.4	21.8	22.7	23.0	20.8
July	22.8	24.5	25.4	26.7	26.8	24.5
August	24.5	26.2	27.1	27.8	28.0	25.3
September	19.9	22.0	23.5	23.6	24.6	21.2
October	13.6	16.0	18.2	17.5	19.0	14.9
November	7.6	10.2	13.0	11.9	13.5	9.2
December	2.8	5.3	8.4	6.9	8.4	4.1
Year	11.4	13.5	15.9	15.6	16.5	13.2

Sunshine (hours)

	Akita	Niigata	Tokyo	Fushimi (Kyoto)	Nada (Kobe)	Saijo (Higashihiroshima)
January	44.6	56.1	180.5	122.4	145.6	120.1
February	65.6	75.9	161.1	113.4	132.1	129.9
March	135.7	130.9	159.2	145.2	158.9	151.4
April	175.0	181.9	164.9	169.7	183.1	186.3
May	191.4	204.8	180.9	181.8	197.8	196.9
June	178.0	168.1	120.1	130.4	146.8	149.2
July	171.5	182.7	147.5	145.6	180.0	171.8
August	200.4	214.8	177.5	176.5	207.4	191.4
September	154.9	146.4	112.9	129.2	146.6	144.5
October	148.1	142.8	129.9	152.2	164.9	169.1
November	84.7	90.0	141.4	135.0	148.5	140.7
December	47.6	59.4	171.1	133.1	154.1	137.7
Year	1597.4	1651.0	1847.2	1734.3	1965.8	1885.6

Precipitation (mm)

	Akita	Niigata	Tokyo	Fushimi (Kyoto)	Nada (Kobe)	Saijo (Higashihiroshima)
January	114.4	180.3	48.6	48.8	38.9	48.2
February	92.0	128.0	60.2	65.2	54.2	61.2
March	93.0	140.6	114.5	112.3	90.8	116.4
April	117.6	93.6	130.3	135.4	121.4	127.1
May	122.8	103.3	128.0	154.9	142.1	148.0
June	127.5	128.3	164.9	229.9	189.6	251.5
July	178.1	178.2	161.5	215.3	145.8	232.2
August	181.9	142.7	155.1	143.7	100.0	137.6
September	177.9	163.0	208.5	204.9	171.4	181.0
October	160.7	148.9	163.1	120.5	106.0	97.5
November	183.5	200.6	92.5	75.2	64.7	70.5
December	163.8	204.4	39.6	41.7	39.8	32.7
Year	1713.2	1775.8	1466.7	1545.4	1264.7	1503.8

8.11 Summary

Table 8.3 summarizes component differences between full-bodied and light-bodied sake and factors influencing the amount of body in sake. The actual brewing process involves combining factors, such as kimoto and ginjozukuri, to produce the desired sake quality.

Table 8.3 Factors influencing amount of body in sake

	Full	Light
Components	High alcohol content High acidity Negative nihonshu-do: high sugar content High amino acid value: rich in amino acids and peptides	Low alcohol content Low acidity Positive nihonshu-do: low in sugar content Low amino acid value: low in amino acids and peptides
Variety of rice	Sake rice (varieties that dissolve easily, such as Yamadanishiki, Omachi)	Sake rice (varieties such as Gohyakumangoku that are less soluble than Yamadanishiki) Table rice
Seimai-buai	High	Low*
Water quality	Hard	Soft
Ratio of water to rice	Low	High
Koji-making style	Sohaze	Tsukihaze*
Shubo	Kimoto, Yamahaimoto	Sokujomoto
Fermentation temperature	High	Low*
Ratio of undissolved solids	Low	High*
Time to pasteurization (namazake period)	Long	Short
Storage temperature	High	Low
Filtering	Unfiltered	Filtered Use of active charcoal

* Essential for brewing ginjo-shu