The Story of Shochu

NRIB
(National Research Institute of Brewing)

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There are many spirits traditions around the world, including whisky, brandy, gin, vodka, tequila, and rum. While most world spirits are enjoyed either as an aperitif or digestif, Japanese shochu is valued for how easily it can be paired with a meal.

The ingredient "koji" mainly makes shochu different from other spirits. Koji mold, used to produce such as liquors, miso, and soy sauce, has played essential part in fermentation culture in Japan for over 1,000 years. In fact, the Japanese Society for Brewing Science declared it Japan's national mold in 2006. These microorganisms are inseparable from Japanese cuisine and foundational to "Washoku, traditional dietary cultures of the Japanese" (2013) and "Traditional knowledge and skills of sake-making with koji mold in Japan" (2024), which were registered UNESCO Intangible Cultural Heritage.

Black and white koji mold strains are used in shochu production because they produce citric acid. Citric acid makes the fermenting mash much more acidic which inhibits the growth of undesired microbes. The mash becomes quite sour, but citric acid is removed by distillation, so shochu does not have a strong acidity.

Yeast, which is responsible for alcoholic fermentation, is also suitable for producing shochu. During shochu fermentation, the koji mold produces citric acid, which makes the mash acidic. Additionally, fermentation temperatures can reach 30℃(86℉), so shochu yeast must have a high fermentation power that can stably continue alcohol production in such a harsh environment.

Various studies have focused on shochu production, which has been around for decades. Even with the progress afforded by modern science, there are still many phenomena that have yet to be fully elucidated. However, we will explain some of the key concepts borne out by science in this booklet.

We will also introduce trends in global shochu export. With "Traditional knowledge and skills of sake-making with koji mold in Japan" inscribed as an intangible cultural heritage by UNESCO, further increases in shochu exports are expected in the years to come.

Shochu's position in the world of distilled spirits

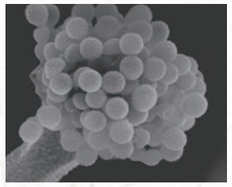
Shochu is finding new fans all over the world.
(Photo credit: Japan Sake and Shochu Makers Association)

Unless otherwise stated, the term "shochu" refers to both "Honkaku Shochu and Awamori" in this booklet. For more information on shochu and awamori classifications, please see "The Story of Shochu 1."

Shochu Production-Related Microbes

Koji mold

Koji mold plays an essential role in shochu production because it produces enzymes that break down starches and proteins in the ingredients, while simultaneously created citric acid prevents undesired microbes from contamination of mash.



An image of koji mold taken by an electron microscope

How black koji mold changed shochu production

Black koji mold has long been used in awamori production, the traditional spirits in Okinawa Prefecture. The citric acid produced by black koji mold makes the fermenting mash highly acidic, which inhibits the growth of microorganisms other than yeast. This allows fermentation safely even in subtropical regions such as Okinawa Prefecture.

Starting in around 1910, black koji mold was introduced into sweet potato shochu production. Before then, yellow koji mold, which does not produce citric acid, was used. This meant that there was usually a risk of contamination by undesired microbes, and it was very hard to guarantee the quality of sweet potato shochu consistently.

Once distilleries in Kagoshima Prefecture began using black koji mold to make sweet potato shochu, the citric acid emitted by the koji mold more effectively protected the mash from contamination by undesired microbes, and the alcohol yields increased by 20-30%, which was hailed as a dramatic success. The shochu also exuded a more refreshing aroma which had never been experienced before. Following its success in Kagoshima Prefecture, black koji mold spread to other regions, revolutionizing shochu production along the way.

Development of white koji mold

In 1924, a white mutation of black koji mold was discovered. Although the spore color differs between white and black koji mold, these two molds share many other properties.

Unlike black koji mold, the new white variant didn't cover the distillery, tools, and workers' clothing with black mold spores. As it can produce shochu of a consistent quality, white koji mold was quickly adopted by the shochu industry.

Selecting koji mold

The power of the koji mold's enzymatic activity varies slightly between strains, and this leads to differences in flavor and aroma.However, the largest differences in flavor profile are attributable to variations in production process from distillery to distillery. All things considered, black koji mold tends to highlight rich, earthy aromas while white koji mold allows milder, rounder notes to shine. Yellow koji mold is known for accenting fruit and flower in the fermentation.

Black and white koji mold are most common in shochu production, but yellow koji mold has found popularity recently. In the hands of a skilled master brewer-distiller, yellow koji mold can be used to make brighter and fruitier shochu expressions.

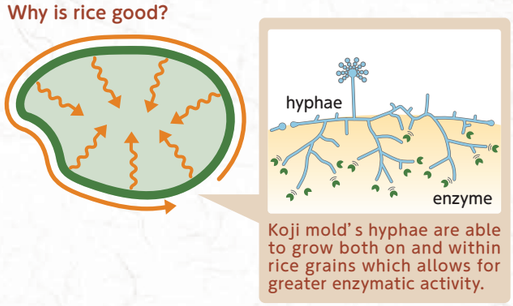
Koji substrate selection (rice, barley, sweet potato, etc.)

The ingredient to which the koji mold is added, also known as the koji substrate, impacts the shochu's flavor, too.

Making koji involves growing koji mold on the chosen ingredient.The ends of koji mold mycelia excrete enzymes that break down starch and proteins found in the koji substrate. The resulting glucose and amino acids are important fuel for fermentation.Therefore, it is essential that koji mold is allowed to grow both on the surface and inside the substrate. Insufficient mold growth leads to weak enzyme activity and reduced citric acid during fermentation.

There are many ingredients used as koji substrates, such as barley, sweet potato, and buckwheat, but rice is the most commonly used ingredient for shochu production.Using barley as the koji substrate presents the challenge of the koji mold only growing on the grain surface. Meanwhile, sweet potatoes are difficult to use because they change shape easily and the surface of buckwheat becomes viscous when steamed. On the other hand, rice avoids these problems and is easier to use.

Why is rice good?



Koji mold's hyphae are able to grow both on and within rice grains which allows for greater enzymatic activity.

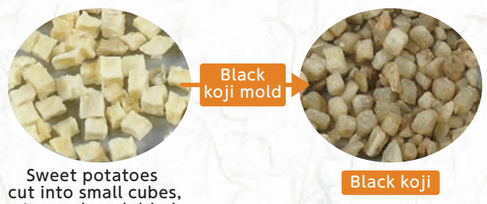
However, shochu distilleries have learned to overcome the obstacles presented by using ingredients other than rice in koji production. Barley koji is commonly used in Oita Prefecture, and both Kagoshima and Miyazaki Prefectures occasionally produce brands with sweet potato koji.

When rice is used as the koji substrate, the grain's characteristic mellow, round aromas appear in the shochu. Barley koji tends to lend a grainy sweetness, and sweet potato koji adds a light and refreshing taste to the drink.

Sweet Potato Koji

Steamed sweet potatoes retain a lot of moisture. As such, it was difficult to grow koji mold on steamed sweet potatoes because they are soft and don't hold their shape.

Some distilleries have figured out how to cube the sweet potatoes and treat them with hot air. Others cube the sweet potatoes, steam them, dry them, and then steam them a second time. The two methods help maintain the appropriate firmness and shape for making sweet potato koji.

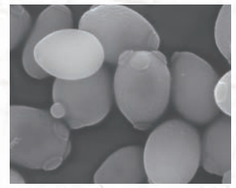


Sweet potatoes cut into small cubes, steamed, and dried

Black koji

Yeast

Yeast plays the crucial role in alcohol fermentation by turning the glucose liberated by koji during the saccharification process into alcohol and carbon dioxide.



Electron microscope image of yeast

Discovery and isolation of shochu yeast

The existence of shochu yeast was discovered in the early 20th century and isolated by researchers at the University of Tokyo. Ever since, high quality shochu yeast has been isolated from various types of mash.

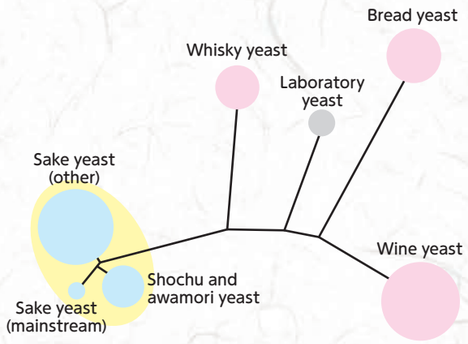
Good shochu yeast strains can continue alcohol fermentations under the following harsh conditions: acidic environment (pH 3) created by citric acid; high temperature environment (20-30℃(68-86℉)); and a relatively high-alcohol mash, and produce good-flavored components.

A fermenting shochu mash becomes acidic due to the citric acid produced by black and white koji mold, which makes it difficult for most other microorganisms to survive. Furthermore, the temperature of the fermenting mash sometimes reaches 30℃(86℉). Shochu yeast is able to reproduce and ferment alcohol continuously under these extreme conditions.

Additionally, since shochu can be made from dozens of approved ingredients, it is necessary for yeast to have a wide range of adaptability given the sheer variety of mash.

Yeast genome analysis

Recently, remarkable advances in biotechnology have led to rapid archiving of genomic (gene) information. While analyzing the yeast genome, it was found that shochu yeast is a nearer relative to sake yeast than wine or whisky yeast. However, there are differences between shochu and sake yeast in terms of alcohol and aromatics production during fermentation, and it is believed that the characteristic factors of shochu yeast is found in these slight genetic differences. More clarity on these differences is pending as further research is undertaken.



Yeast genetic relationships:
Fewer difference in gene sequences indicates a relatively closer relationship (conversely, the greater the differences, the greater the distance between strains). Shochu yeast displays larger variations to wine and whisky yeast strains than to sake, indicating a closer relationship to the latter.

Shochu Science

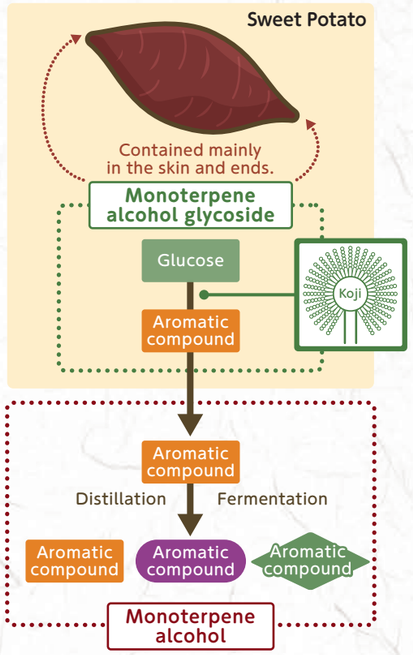
Sweet potato shochu aromatics

Monoterpene alcohol is one of the representative compounds found in sweet potato shochu. Monoterpene alcohol is a group of compounds containing terpenes, and its aroma is similar to lychee or muscat. Sweet potato shochu contains a variety of monoterpene alcohols.

These alcohols present as aglycones attached to glucose molecules.This glycosidic bond is broken down into glucose and monoterpene alcohol by enzymes in koji. Liberated monoterpene alcohols experience further changes via yeast metabolism and distillation under acidic conditions.

The enzymatic activity that breaks down glycosides is reportedly stronger in black koji mold than in white, so the aromatic influence of monoterpene alcohols is influenced by which type is used. Since such glycosides are abundant in the skin and ends of sweet potatoes, monoterpene aromatics can be increased by using small sweet potatoes with a high skin ratio, or decreased by cutting off the ends.

Other common sweet potato aromas include yogurt-like notes from purple sweet potatoes and even carrot- or pumpkin-like aromas from orange sweet potatoes. There are scientific reasons why the aroma of sweet potato shochu varies depending on the type of sweet potato, processing method, and type of koji mold.



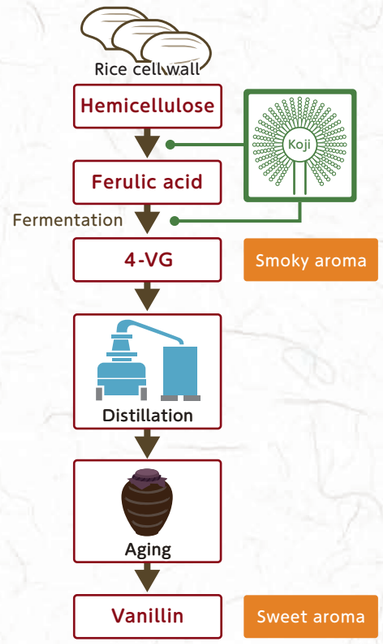
Aged awamori aroma

Aged awamori is loved for its sweet aroma.

In barrel-aged whisky, the sweet aroma of vanillin is produced through the thermal decomposition of the cask. The same vanillin is also found in aged awamori. Awamori is often aged in clay pots, so it lacks the barrel flavors found in whisky. So where does the vanillin in aged awamori come from?

The answer was found in koji. Hemicellulose in rice cell walls is deconstructed by koji mold' s enzymes, which releases ferulic acid. The ferulic acid is converted 4-VG (4-vinylguaiacol, a smoky aroma) by another enzyme in koji mold during fermentation, and then undergoes further chemical changes during aging to become the sweet aroma vanillin.

In addition, it has been discovered that the aroma profile of aged awamori contains multiple components other than vanillin.



Exploring the secrets of next-generation awamori

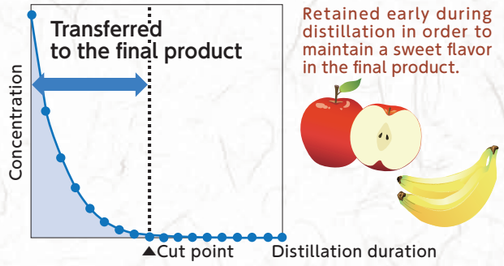
In recent years, a new production has been added to the production of the traditional Japanese distillate, awamori. That is "triple distillation." Awamori is normally distilled once in a pot still, but this new method involves three distillations. Triple-distilled awamori is lighter than traditional awamori and tends to have a sweet flavor and cleaner finish. This new style has helped attract distillation experts around the world.

To clarify what contributes to the flavor profile of triple-distilled awamori, we analyzed component behavior during distillation. During awamori distillation, fruity esters vaporize and leave the still at lower temperatures while earthier, richer, and smokier components can be extracted at higher temperatures. These more traditional aromatics perceived as bitterness and miscellaneous tastes when present in large amounts can be limited by cutting the second half of distillation according to the desired quality.

By distilling the awamori three times, there is greater accuracy in the separation of aromatic compounds. To summarize, repeated distillation concentrates the fruitier components while reducing the heavier and more complex aromatics, resulting in a sweet flavor profile and clear finish.

Through this scientific analysis, the distinctive features of rich-flavored awamori produced through a single distillation process and those of next generation awamori have been clearly elucidated.

Distillation behavior of fruit-like components



Distillation behavior of smoky components

Safety of black koji mold

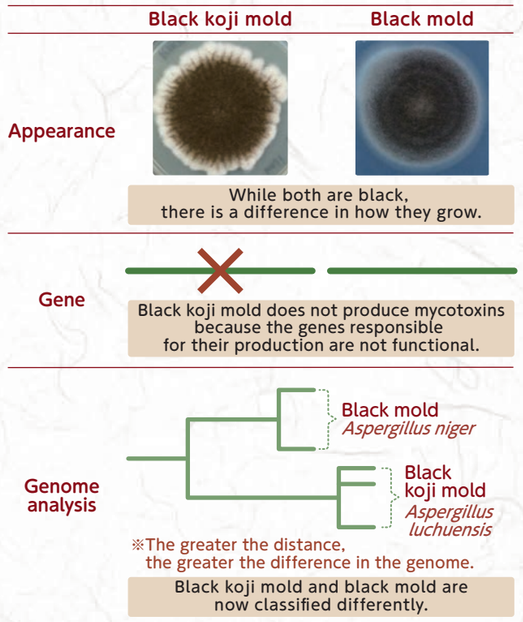
Black koji mold protects healthy and stable fermentation by producing citric acid and is an extremely important fungus in shochu and awamori production.

That said, some black mold strains used to produce citric acid elsewhere in the world also produce dangerous toxins.

Since 1920, due to the resemblance of black koji mold to these other strains, there have been calls from overseas to classify them in the same category. But since the classification has mainly been based on morphological observations, the taxonomic relationship between these black mold strains remains unclear and confusing.

Therefore, we conducted genome analysis and clarified that black koji mold is unrelated to black mold. Crucially, the gene responsible for producing mycotoxins is not functional in black koji mold. As a result, in 2013 the scientific name of black koji mold was recognized internationally as *Aspergillus luchuensis*.

The study confirmed at the genetic level that black koji mold, which has been used in Japanese fermentation for centuries, is indeed safe.



Shochu Science

Honkaku shochu and awamori flavor wheel

Made with a wide variety of ingredients and manufacturing methods, honkaku shochu and awamori exhibit and unparalleled flavor and aroma spectrum, giving each product its unique character. Up until now, consumers have used a variety of terms to describe these drinks, often making it difficult for effectively describe the flavors and aromas at play.

This is where the “flavor wheel” comes in. A flavor wheel is a circular, layered arrangement of the characteristic aromas and flavors found in a food or drink. They can be used by food and drink enthusiasts to share their aroma and flavor notes more accurately.

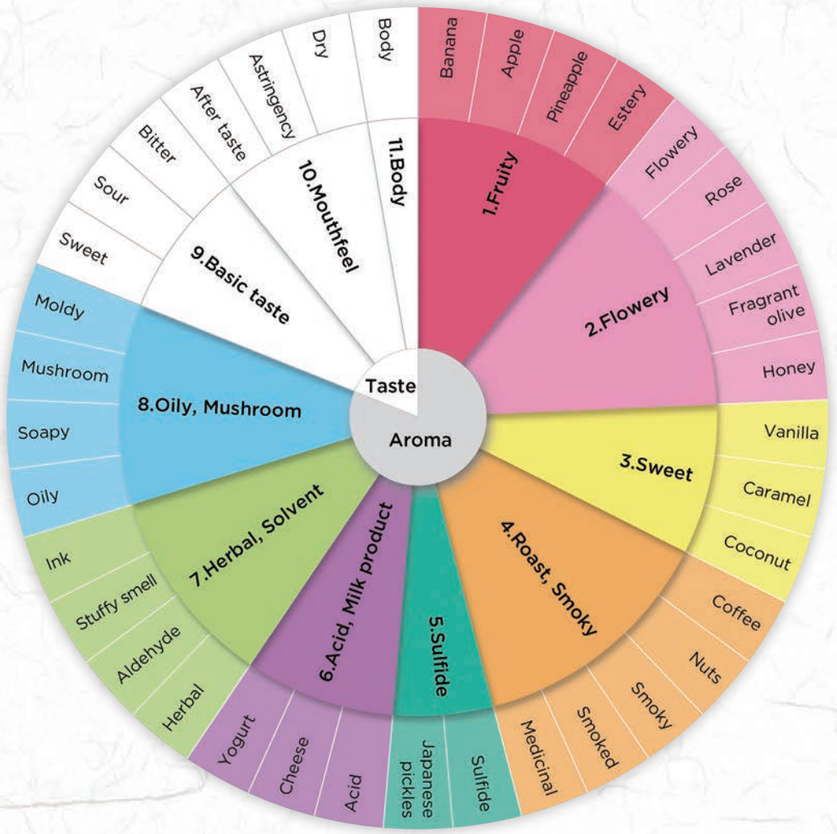
How to read the flavor wheel

This honkaku shochu and awamori flavor wheel has two circles, one large and one small.

The inner section of the wheel contains eight aroma groups, such as “fruity” and “flowery,” and taste groups, such as “basic taste,” “mouthfeel,” and “body.”

The outer section of the wheel contains 30 detailed expressions for aroma and seven for flavor.

As you can see, the flavor wheel categorizes flavors hierarchically. When describing the flavor and aroma of a particular honkaku shochu or awamori, begin with the words in the inner section before moving on to more specific notes in the other portion. This will help you to capture the aroma and flavor profile in detail and describe them in common terms.



Honkaku shochu and awamori flavor wheel:
The National Research Institute of Brewing spent about three years refining this wheel.

Click here for an explanatory video

Honkaku shochu and awamori flavor wheel

Honkaku shochu and awamori flavors

Using the flavor wheel

One of the most representative ways to use this honkaku shochu and awamori flavor wheel is “aroma quality visualization.” If a distillery has sensory evaluations of the intensity of various aromatic compounds from the flavor wheel, they could visualize the aroma quality by displaying the results in a spider chart.

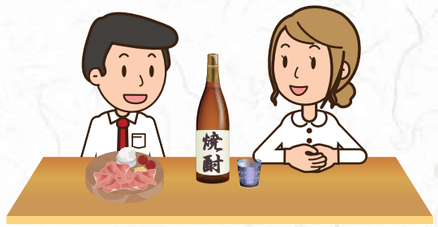
There are two main benefits to “visualizing” data using charts.

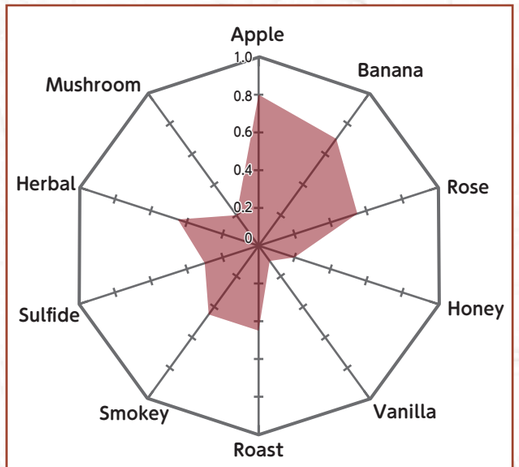
The first is product design. By scrutinizing the resulting charts, it is possible to make adjustment in the direction of future product development. Charts can also be used to compare target product quality with what is currently being produced. The charts help visualize which aromas need to be strengthened or weakened, thereby improving product quality incrementally.

The second advantage is related to sales. By visualizing shochu characteristics using spider charts, the unique features of each alcohol beverage product can be clearly conveyed to consumers. The charts can also be used in sales to consumers.

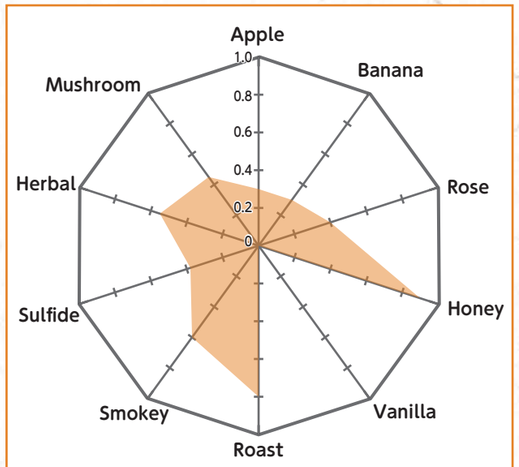
A future guided by the flavor wheel

The honkaku shochu and awamori flavor wheel makes it possible for various shochu and awamori stakeholders, including producers, distributors, retailers, consumers, and researchers, to share a common understanding and communicate about their flavors. The day when people from all corners of the globe feel more familiar with shochu and awamori and enjoy them as a natural accompaniment to their meals may not be too far off.





Fruity and vibrant aromas



Honeyed and savory aromas

➡ Shochu characteristics at a glance

Aroma quality visualization (spider chart):
The shochu on the left side has strong fruity notes of apple and banana. Shochu with pronounced fruity notes can often be traced directly back to the esters produced from yeast fermentation. In contrast, the shochu on the right side of the chart has a clearly fragrant, honey-like aroma, which are characteristic of sweet potato shochu. It also has moderate smokiness.

Shochu's Global Spread

Expanding export potential

The export value of shochu has been rising.

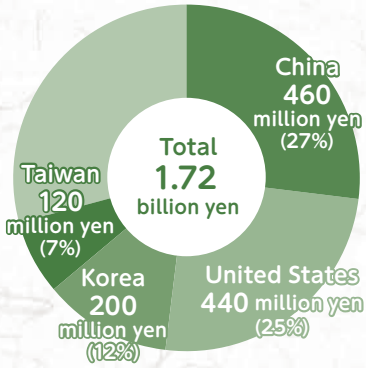
Trends in the value of shochu exports

(Billion yen)

※The total amount includes pot distillation shochu, continuous distillation shochu, and shochu that blends the two.

Export partners can be found in China, the United States, Korea, Taiwan, and more than 30 other countries worldwide. In particular, China and the United States account for more than 50% of total amount, demonstrating their importance to the international expansion of shochu.

Export value by country (2024)



Source:
Ministry of Finance Trade Statistics

Honkaku shochu and awamori have enjoyed more shipments in Japan, too, doubling over the past 30 years. Due partly to robust domestic sales, shochu and awamori makers have been slow to actively expand international markets, and efforts to expand exports remain tepid.

Against this backdrop, in 2020 the Japanese government set an ambitious target for increasing the export value of food and drink products to five trillion yen by 2030. Honkaku shochu and awamori were declared priority products in this effort. We are conducting various activations to increase interest in and awareness of shochu, such as shochu tasting events at bars overseas and bringing international drinks experts to Japan to visit distilleries.

"Traditional knowledge and skills of sake-making with koji mold in Japan (Japan's traditional brewing)" inscribed on the UNESCO Intangible Cultural Heritage List

In December 2024, "Japan's traditional brewing", which is used to produce honkaku shochu, awamori, and other alcohol beverage products, was inscribed on the UNESCO Intangible Cultural Heritage List.

Ceremony to commemorate to be inscribed on the UNESCO Intangible Cultural Heritage List

UNESCO Intangible Cultural Heritage recognition is intended to safeguard the Intangible Cultural Heritage at the international level and raise awareness of its significance. The registry includes intangible cultural aspects such as traditional craft techniques and social customs. For instance, in terms of alcoholic beverages, "Ancient Georgian traditional Qvevri wine-making method" is also registered.

"Japan's traditional brewing" refers to the skills of toji (chief sake makers) and kurabito(sake brewery workers), who traditionally use koji mold to make sake. It has been developed depending on the climates and environment of various regions in Japan.

The National Research Institute of Brewing supports "Japan's traditional brewing" by encouraging improvements in technology and techniques, and providing storage services for koji mold.

Foundational techniques of "Japan's traditional brewing"

- Adjust the moisture content of the raw materials and steam them
- Making koji using traditional koji mold
- Saccharification and alcohol product occur simultaneously during fermentation

How koji is made

In the decade after "washoku" (traditional dietary culture of the Japanese) was inscribed on the Intangible Cultural Heritage List in 2013, it is said that the number of Japanese restaurants overseas more than tripled. With "Japan's traditional brewing" inscribed on the Intangible Cultural Heritage List, there are high expectations for expanding awareness of shochu overseas followed by further growth in exports.

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