

FOOD CULTURE

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Feature

Japanese traditional sake brewing
inscribed as a UNESCO Intangible
Cultural Heritage

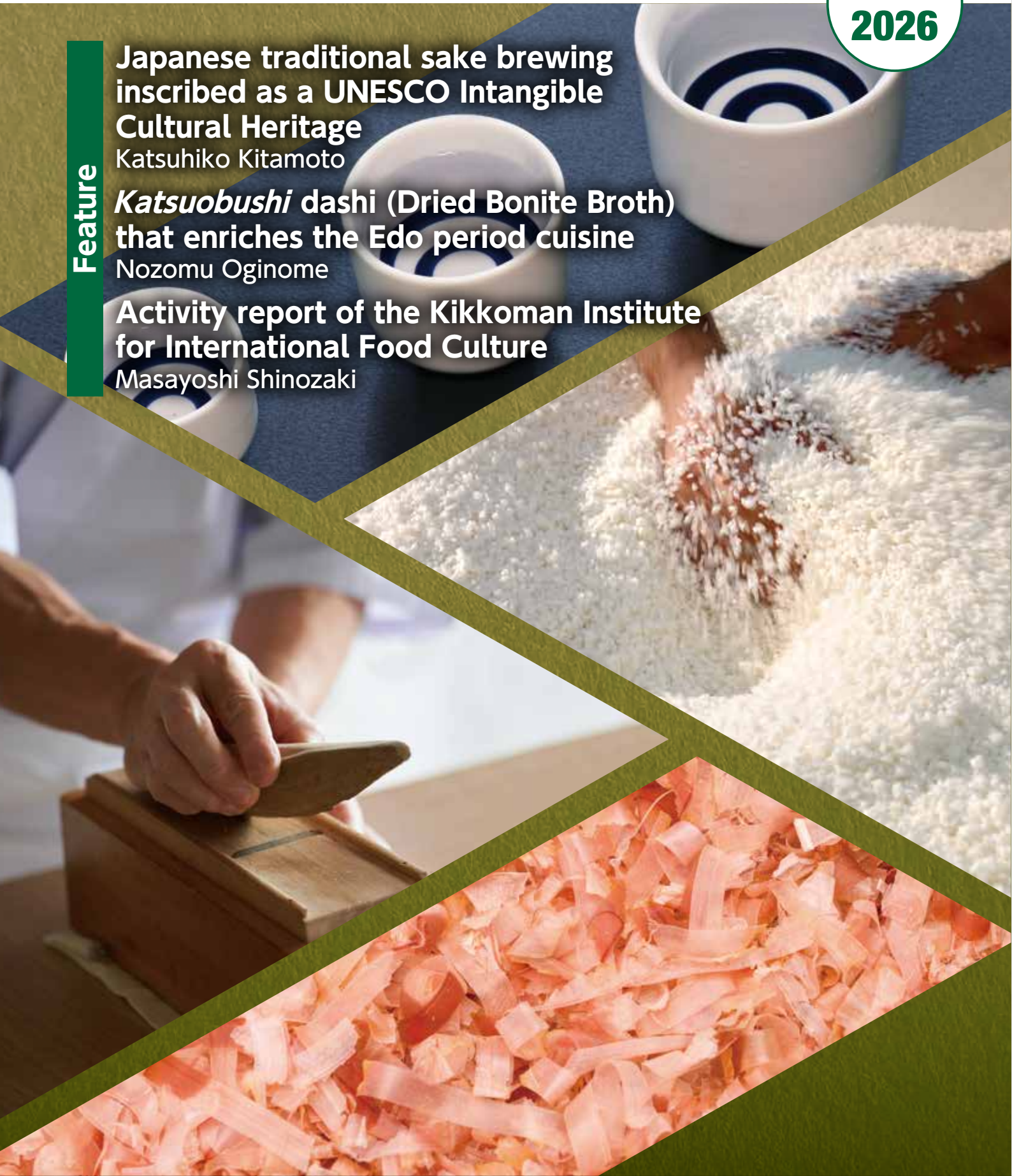
Katsuhiko Kitamoto

Katsuobushi dashi (Dried Bonite Broth)
that enriches the Edo period cuisine

Nozomu Oginome

Activity report of the Kikkoman Institute
for International Food Culture

Masayoshi Shinozaki



Greetings

What we commonly use at the table or eat every day have the history of their origins or stories about the production methods or features. To learn those histories and stories can lead to a new way of enjoying food. Exploring such common things is one of the missions of our institute. This is why we feature *katsuobushi* (dried bonito or skipjack tuna) and Japanese traditional sake brewing in this issue.

Thanks to the development of packaged *katsuobushi* flakes, which keep long, fresh *katsuobushi* is readily available at any time. However, we now seldom grate *katsuobushi* at home. It is a pity that the memory of rich flavor imparted by freshly grated *katsuobushi* is fading.

Japan's traditional sake brewing was added to the UNESCO Intangible Cultural Heritage list in December 2024. The inscribed heritage covers sake, *shochu* spirits, *awamori* (Okinawa's iconic spirit), *mirin* (sweet rice wine), and other alcoholic beverages brewed in Japan using *koji* mold since ancient times. Understanding how Japan's original brewing technology has been developed and what features it has is very important in passing on our traditional culture. This issue provides detailed but easy-to-understand summaries written by specialists based on the knowledge gained through their research. We hope this journal will help you place a renewed focus on familiar food culture and make your dinner table more enjoyable and enriched.

In addition, we included reports of two exhibitions on advertisement among the themed exhibitions of our collections started in 2024 to show our institute's archives usually not open to the public. Again, by tracing changes in familiar advertisements, you will see transitions in Japan's daily culture at these exhibitions.

While continuing to plan diversified projects leveraging the collections, the Kikkoman Institute for International Food Culture will make efforts to offer new perspectives and insights through explorations of food culture.

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Japanese traditional sake brewing inscribed as a UNESCO Intangible Cultural Heritage

—Functions and importance of *koji* mold

Katsuhiko Kitamoto, Professor Emeritus at the University of Tokyo and Research Professor at Nihon Pharmaceutical University

1) Inscription of traditional sake brewing on the UNESCO Intangible Cultural Heritage list

Following the registration of washoku as a UNESCO Intangible Cultural Heritage in 2013, traditional sake brewing was also inscribed on the list in 2024. Careful preparations were made for the application through the registration, including procedures in Japan.

First, registration as a registered intangible cultural property of Japan was needed. To that end, the Preservation Society of Japanese *Koji*-based Sake Making Craftsmanship (president: Shinemon Konishi) was established in April 2021. On October 15, 2021, the Council for Cultural Affairs submitted a report to the Minister of Education, Culture, Sports, Science and Technology and recommended that the traditional sake brewing, i.e., brewing technology using Japan's traditional *koji* mold, should be registered as a registered intangible cultural property of Japan. In the meantime, the National Tax Agency was conducting research on sake brewing using Japan's traditional *koji* mold. The agency announced the result in December 2021 (https://www.nta.go.jp/taxes/sake/koujikin/pdf/0021012-102_01.pdf). The report was supervised and contributed by Eiji Ichishima (Professor Emeritus at Tohoku University and the Tokyo University of Agriculture and Technology), Noritake Kanzaki (former director of the Institute for the Culture of Travel), Katsuhiko Kitamoto (Professor Emeritus at the University of Tokyo and Research Professor at Nihon Pharmaceutical University), Takeo Koizumi (Professor Emeritus at the Tokyo University of Agriculture), Nami Goto (former president of National Research Institute of Brewing), Yoshihiro Sameshima (Former professor at Kagoshima University), John Gauntner (Sake World), and Kenjiro Monji (former UNESCO Ambassador). The report was compiled in a short time, but it goes into detail about traditional sake brewing, including the importance of *koji*.



Katsuhiko Kitamoto

After graduating from the Faculty of Agriculture of the University of Tokyo in 1972, pursued research on sake yeast and *koji* mold at the National Research Institute of Brewing of the National Tax Agency and at the University of Tokyo. Currently, Research Professor at Nihon Pharmaceutical University, Professor Emeritus at the University of Tokyo, and president of the Japanese Society for Brewing Science.

He has authored several books, including *Washoku to Umami no Misuteri—Kokusen Kojikin Orizoga Tsumugu Sennen no Monogatari* (mystery of *washoku* and *umami*—a 1000-year story woven by Japanese *koji* mold, *Aspergillus oryzae*), Kawade Shobo Shinsha (2016); *Jozo no Jiten* (brewing encyclopedia), Asakura Publishing (2021); *47 Todofuken Hakko Bunka Hyakka* (47-prefecture fermentation culture encyclopedia), Maruzen Publishing (2021); and *Hakko Jozogaku* (fermentation and brewing science), Asakura Publishing (2022).

On February 25, 2022, “Traditional knowledge and skills of sake-making with *koji* mold in Japan” was selected as a candidate to propose for the inscription on the UNESCO's Intangible Cultural Heritage list by the Intangible Cultural Heritage Subcommittee of the Council for Cultural Affairs. However, it was not examined because the number of nomination files submitted by Japan exceeded the limit for that year. On March 8, 2023, the Intangible Cultural Heritage Subcommittee held a meeting and selected “traditional sake brewing” again to propose for the Representative List of the Intangible Cultural Heritage of Humanity. A nomination of the proposed element was submitted and, after a one-year examination, the Evaluation Body of the Intergovernmental Committee for the Safeguarding of Intangible Cultural Heritage recommended “inscription” on November 5, 2024. The Intergovernmental Committee decided to inscribe the element on the Representative list at its 19th meeting held in Paraguay on December 5, 2024 (Figure 1). This decision on the inscription was extensively covered by TV and other media in Japan. I recall that sake breweries across the country appeared repeatedly on TV. The project was completed about five years after the preparations were first made with the National Tax Agency and the Agency for Cultural Affairs playing a central role.



Figure 1. Certificate of inscription by UNESCO

2) Three types of *koji*

When the sake brewing was nominated, there were three UNESCO Intangible Cultural Heritages related to alcoholic beverages: Georgian wine (2013), Belgian beer culture (2016), and Mongolian airag (fermented mare milk) (2019). Something was needed to differentiate sake from these beverages. It was “sake-making with *koji* mold

in Japan.” In Japanese *koji* is written in hiragana, which seems strange to a *koji* mold researcher. In technical terms, kanji 麹 is used. In fact, *koji*, long used for sake, miso, and soy sauce, is written in several different ways. Besides 麹, another kanji 糴 is also used.

The character 麹 comes from China. It is pronounced “*koji*” in Japanese reading and “*kiku*” in Chinese reading. As it has Japanese reading, it is considered that *koji* was already used in Japan when this kanji was brought from China in the 7th century. Some kanji, such as 茶 (tea) and 菊 (chrysanthemum), do not have Japanese reading. This indicates that they didn’t exist in Japan when these kanji were introduced. The kanji like 糴 were created in the Edo period. They are called *kokuji* (national character). Naturally, they have only Japanese reading. The radical of 糴 is 米 (rice) whereas that of 麹 is 麦 (wheat). It makes sense because rice is used for Japanese *koji*. **Figure 2** shows the photos of *barakoji* (loose *koji*) used for Japanese sake brewing and *mochikoji* (caked *koji*) used for Chinese Shaoxing wine. *Koji* for Shaoxing wine is produced using wheat not rice. The reason why *koji* is written in hiragana in the title for the inscription seems to be that hiragana is used instead of kanji 麹 in the Japanese Liquor Tax Act. In this article, 麹 is used as it is the most commonly used character.



Barakoji: *Koji* used for sake



Mochikoji: *Koji* used for Shaoxing wine, also called *bakkyoku* (wheat *koji*)
(Provided by Mr. Ryokon Natsu, Guyue Longshan)

Figure 2. *Barakoji* and *mochikoji*

3) Roles of *koji*

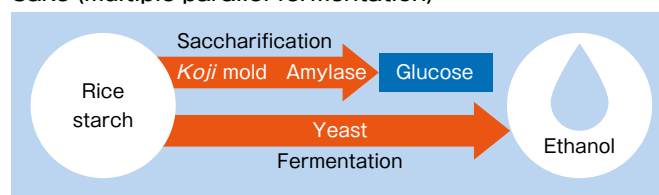
Umami (savoriness) of washoku is imparted by miso, soy sauce, mirin, vinegar, sake and other food made with *koji*. You could say *koji* mold is a key player that determines the taste of washoku. *Shiokoji* (salt *koji*), a relatively recent fad in Japan, is now attracting attention

across the world. *Koji* mold has also been used for other purposes besides food for a long time. A typical example is Takadiastase, a digestive enzyme preparation put to practical use by Jokichi Takamine in 1894. This preparation is still widely used as a component of digestive medicines.

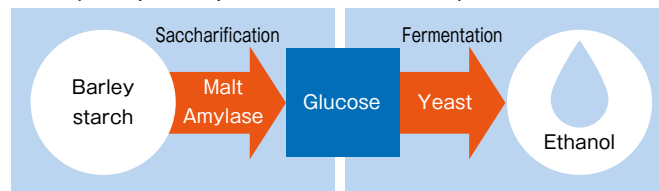
Koji mold is also used for production of useful proteins as the host for genetic engineering. An example is an enzyme preparation added to a detergent. This is alkaline lipase produced from *Humicola lanuginosa*, a filamentous fungus, using *koji* mold. *Humicola lanuginosa* normally produces only a small amount of lipase, but the production is increased by introducing its gene into *koji* mold.

Alcoholic beverages are produced in various traditional processes across the world (**Figure 3**). The simplest example is wine making. Sugar in grapes is fermented directly by yeast to produce alcohol. Most of alcohol drinks in the world are made from staple grains, such as sake and Shaoxing wine from rice and beer from barley. Yeast cannot directly ferment starch contained in grains and needs a process of converting starch to sugar. Specifically, starch is decomposed into glucose or other sugars by amylase (saccharification enzyme) and then alcohol is produced by yeast. In this saccharification process, mold amylase is used in Eastern countries and barley amylase in Western countries. *Kuchikamizake* (mouth-chewed sake) has been made around the world. *Kuchikamizake* is made by chewing a grain or any other starchy material, spitting it into a container, and allowing it ferment naturally. Amylase in saliva breaks down starch into sugars. While kept in the container, the sugars are fermented by yeast and alcohol is produced. *Kuchikamizake* is found in Southeast Asia, the South Pacific region, South America, and other parts of the world.

Sake (multiple parallel fermentation)



Beer (multiple sequential fermentation)



Wine (simple fermentation)

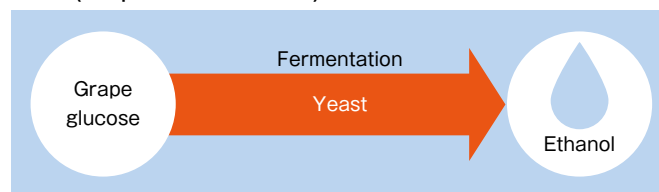


Figure 3. Fermented alcoholic beverages

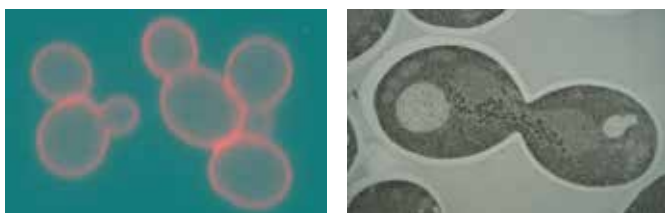
There is a theory that a verb *kamosu* (brew alcoholic beverages) is derived from *kamu* (chew) of *kuchikamizake*. Another theory suggests that it comes from *kabu* meaning to grow mold (*kabi*). It might have changed from *kamu* to *kabiru* (*kabu*) and then to *kamosu*.

The scientific name of *koji* mold used for sake is *Aspergillus oryzae*. It is a type of filamentous fungus forming hyphae made of long thin cells connected. It is different in shape from sake yeast, which is oval. As the mold grows, a stalk called a sporangiophore rises and forms spores (Figure 4). *Oryzae* means rice and thus *A. oryzae* is a mold species of the Genus *Aspergillus* that grows on rice. Spores are called a *koji* starter or *moyashi* in sake making.

Koji mold: *Aspergillus oryzae*



Sake yeast: *Saccharomyces cerevisiae*



Kyokai No.7 yeast

Figure 4. *Koji* mold and sake yeast

Koji serves the following functions in sake brewing. First, *koji* is made by spraying a *koji* starter over steamed rice and culturing for 44 hours. *Koji* contains various hydrolytic enzymes, including amylase and protease. In particular, amylase is the most important. It converts rice starch to glucose. Glucose is then converted to alcohol by yeast, which makes sake. Protease functions to produce *umami* components, such as amino acids and peptides. *Koji* also has functions to supply nutrients like vitamin and mineral to yeast to help yeast to multiply. Genome information of *koji* mold indicates that it can produce more than 100 kinds of hydrolytic enzymes. Besides amylase and protease, many other enzymes, although limited in quantity, also have effects on the flavor of sake. In fermented mash, glucose made with saccharification by *koji* is converted by yeast into alcohol. *Koji* includes protease besides amylase. Amino acids and peptides produced in this process multiply yeast and greatly influence the flavor of sake. Two totally different processes, saccharification and fermentation, take place simultaneously in mash. This is called multiple parallel fermentation. It is the reason why sake has nearly 20% Alcohol By Volume, the highest among all the fermented beverages in the world.

4) Types of *amazake* and health benefits

Amazake (sweet sake) has two types. They are *koji amazake* and sake lees *amazake*. *Koji amazake* does not contain alcohol, but sake lees *amazake* contains a small amount of alcohol (below 1%).

Koji amazake has been around for a long time. In the Edo period, *amazake* was popular and *amazake* vendors were a common sight of summer. People had *amazake* particularly in summer probably because they knew that nutritious *amazake* prevented summer fatigue and that it was an energy boost.

Recently research into the functional components of *amazake* has made progress and it is now known that sake lees and rice *koji* contain a lot of components good for health and beauty care as listed below. As to antioxidant (anti-aging) effects, antioxidant activity of *amazake* was reported (Sojo University in 2007, Kanazawa Institute of Technology in 2009, Kanazawa University in 2011) and ergothioneine was found as an antioxidant of *amazake* (Hakkaisan Brewery in 2016). Reports on improvement to digestion and gut flora include bifidogenic growth stimulating oligopeptide in rice bran *koji* (Kikkoman in 1991), an increase in beneficial gut bacteria by intake of acid protease of rice *koji* mold (Hiroshima University in 2016), gut microbiome improvement by glucosylceramide contained in *koji* (Saga University in 2016). Ergothioneine, often called longevity vitamin, is now in the spotlight from its high antioxidant activity. There are also moisturizing components, including glucosylceramide contained in *koji* (Saga University in 2016) and α -ethyl glucoside produced by α -glucosidase of *koji* (Kanazawa Institute of Technology in 2018).

Amazake is also called a drinkable Intravenous drip. Enzymes of *koji* mold break down starch in rice into glucose and protein into amino acids. *Amazake* is rich in glucose, essential amino acids, B vitamins (e.g., vitamins B1, B2 and B6, folate, biotin, niacin, and pantothenic acid) and good for recovery from fatigue. No *amazake* claimed to be functional food was on the market as its functionality research was lagging behind unlike yogurt until Hakkaisan Amasake was launched as the first *koji*-derived functional food in 2024. The label states that *Aspergillus oryzae* strain HJ1 *koji* mold improves the intestinal environment and bowel movements and the *koji*-derived glucosylceramide helps keep moisture in the skin. It is expected that many more functional *amazake* products will be launched just like yogurt.

The *amazake* market expanded explosively from 11.9 billion to 16.7 billion yen in 2015, and to 24.6 billion yen in 2017. The consumption has recently begun to rise again from expectations for an immunity boost and some believe that the second boom has come.

5) History of *amazake*

Nihon Shoki (the Chronicles of Japan) compiled in the Nara period (710-784), completed in 720, states that *amanotamusake* was brewed by a goddess *Konohananosakuyabime*. *Amanotamusake* is considered to be something similar to present-day *amazake*. *Yoro Ritsuryo Yoro Rei* (administrative code in the *Yoro Ritsuryo* Code) in the Nara period shows that

mikinotsukasa (bureau of sake brewing) was set up and 醴 (pronounced *kosake* or *amazake* in Japanese reading and *rei* or *rai* in Chinese reading) made in a similar way to *amazake* was brewed. *Engishiki* (detailed procedures for enforcing *ritsuryo* codes) compiled in the Heian period (794-1185) indicates that 醴 was made in June and July.

In the middle ages, large temples like Bodaisan Shoryakuji and Amanosan Kongoji began to make *soboshu* (temple-brewed sake) and shops brewing and selling sake emerged in town. Besides sake shops, *koji* makers also emerged. Among them, *kojiza* (*koji* guild) of Iwashimizu Hachimangu (Yawata-shi, Kyoto) and Kitano Tenmangu (Kamigyō-ku, Kyoto-shi) are well known. *Koji* was used for making not only sake but also *amazake*. In the Muromachi period (1336-1573), *koji* vendors peddled on the street in Kyoto. In the *Nippo Jisho* (a Japanese-Portuguese dictionary compiled by Jesuit missionaries in 1603), there is an entry for *amazake*. It says “*Amazake*: Fermented juice still bubbling and not fully changed to alcohol, or sweet sake.” This indicates that the word *amazake* was already used at the beginning of the Edo period. According to *Chirizukadan* (a collection of essays) in the mid to late Edo period, *amazake* was originally sold in cold winter in Edo, but it was later sold in hot summer as well. It also says that *amazake* shops sold throughout the year.

Morisadamanko (encyclopedia on customs and traditions) published at the end of the Edo period mentioned *amazake* sales by peddlers in Edo (Tokyo) and Keihan (Yodo river basin between present Kyoto and Osaka). A cup of *amazake* cost 8 *mon* (the smallest unit of old currency) in Edo and 6 *mon* in Keihan. *Amazake* was so familiar to common people that it often appeared in *rakugo* (the art of storytelling) stories. Especially in Keihan, *amazake* was popular as a midsummer drink. It was a summer delight that also helped beat the heat and supplement nutrition. It was a *kigo* (season word) for summer in *haiku*. There are two *amazake* originating in the Edo period in Kanda Myojin: Myojin *Amazake* of Amanoya and Enju *Amazake* of Mikawaya Ayabe Shoten. A drawing of a *koji* room put up in front of Amanoya shows that *koji* was made in a room dug underground. An excavation survey reveals that *koji* was also made in a basement like this near Akamon (red gate) of the University of Tokyo on the Hongo plateau.

6) Intestinal immunity and superorganism

It is empirically known that fermented food like *amazake* boosts immunity. Today, it is said that Japanese people's intestinal environment is deteriorating because of changes in eating habit and lifestyle. Some point out that one of the reasons for increases in allergic and autoimmune diseases, which were rarely reported before, is changes in the intestinal environment.

The intestinal immune system is an important system accounting for about 70% of the whole immune system. It identifies pathogenic bacteria and eliminates them. However, in excessively hygienic conditions just as in modern Japan, immune responses become too sensitive and cause atopic dermatitis or hay fever. A human has

approximately 38 trillion cells, but 70 to 100 trillion bacteria of 100 to 200 types reside in the intestine. Bacteria outnumber the human cells. A Nobel laureate Dr. Joshua Lederberg proposed to call human and bacteria collectively superorganism in 2000. The idea is that a human is made up of human cells and bacteria living in the body.

It is becoming clear that health of a human (host) depends greatly on the types of bacteria living in the intestine. Specifically, obesity, dementia, and even lifespan can be influenced as indicated by rat and other experiments. By the way, the word superorganism appears in a game entitled Nyanko Daisensou or The Battle Cats (a game app released in 2010). Dr. Lederberg was 10 years ahead. There is a theory about intestinal immunity called hygiene hypothesis. In 1989, David Strachan conducted a 23-year follow-up survey on 17,414 British people and suggested that lack of exposure to bacteria and viral infection in childhood, i.e., being hygienic, would lead to allergic diseases, including hay fever. This is the hygiene hypothesis he proposed. It is a hypothesis, but similar epidemiological surveys conducted in Europe, Japan and many other countries and regions indicated similar results to Strachan's hypothesis.

According to this hypothesis, eating yogurt is considered to be effective since intake of *Lactobacillus* results in a virtual bacterial infection. In the environment, there are various microorganisms, such as bacteria, molds, and yeasts. *Lactobacillus* is a type of bacteria and safe microorganism. As to safe microorganisms among molds, what comes to mind are molds used for food, including *koji* mold of miso and soy sauce and blue mold for Roquefort cheese. With *amazake*, you can drink *koji* mold as is. It may be the most ideal way to take in safe mold. Sake and miso are also rich in healthy components. However, they contain ethanol and salt, respectively, making excessive intake harmful to your health. That is not the case with *amazake*.

Nihon Pharmaceutical University started an *amazake* project in April 2016, with the aim of getting the various functions (e.g., health and beauty care) of *koji* mold widely known. **Figure 5** shows the roadmap presented at the kick-off meeting. Although the goal for 2025 of more than 20% exceeding in production and consumption volumes of *amazake* over yogurt is yet to be achieved, the consumption has been steadily increasing. Perhaps “The atopic dermatitis and hay fever cases may be reduced by 10% (!)” is not true yet, but I hope it will be in 10 years. Then, *amazake* will become something that reduces national health care spending and contributes to the health and well-being of Japanese people. I am sure that findings of the functionality research of *koji* mold, which is still lagging behind, will help explain the health benefits of *washoku*.

Nihon Pharmaceutical University *Amazake* Project

Started in April 2016

It is aimed at getting the various functions (e.g., health and beauty care) of *koji* mold widely known.

Roadmap

2016: Launch of the first *amazake* (*amakoji* - sweet *koji*) by Nihon Pharmaceutical University

2017: Launch of the second and third *amazake*. Launch of *amazake* by the University of Tokyo. (Research on the health benefits of *amazake* makes progress.)

2020: *Amazake* becomes so popular that leading food manufacturers begin to make and sell *amazake*.

2021: Food manufacturers and universities across Japan begin to report on their research on functionality of *amazake* (*koji* mold). (Scientific evidence of the functionality of *koji* mold accumulates.)

2025: *Amazake* exceeds yogurt in production and consumption volumes by more than 20%.



Koji curry developed by Nihon Pharmaceutical University with Inoue Spice Industry Co., Ltd. (September 2018)

The atopic dermatitis and hay fever cases may be reduced by 10% (?) in Japan!!

Reducing national health care spending!! Contributing to the health and wellbeing of Japanese people!!

The functionality of *koji* mold will help explain the health benefits of washoku.

Figure 5. Nihon Pharmaceutical University *Amazake* Project

The University of Tokyo also started an *amazake* project at about the same time. Their *amazake* was launched in July 2020. Unlike Nihon Pharmaceutical University, which is a single-faculty college, the University of Tokyo is a large organization. It took longer than expected to go through a required process, such as product presentation at the university administrations, selection of a manufacturer, and decision on sales method, and thus their product was launched far behind schedule. They used rice produced by their Faculty of Agriculture (Tanashi farm) and *koji* mold isolated by Kinichiro Sakaguchi, who was called the god of sake.

In 2018, Nihon Pharmaceutical University launched *koji* curry developed jointly with Inoue Spice Industry Co., Ltd. as a spin-off of the *amazake* project. The concept is Japanese-style curry. It is characterized by the use of rice flour instead of wheat flour and *amazake* instead of sugar to give a mellow flavor.

7) *A. oryzae* is a microorganism domesticated in Japan

A Japanese industry-academia-government research team completed genome analysis of *koji* mold in 2005. The result reveals that the genome size of *koji* mold is 37 megabases with approximately 12,000 genes. Its genome size is about three times as large as that of sake yeast and the number of genes doubles that of sake yeast. *Koji* mold is a higher microorganism than yeast with much more complex structure.

On October 12, 2006, Professor Emeritus at Tohoku University Eiji Ichishima delivered a keynote speech entitled, “*Koji* mold is a national microbe,” at the meeting of the Japanese Society for Brewing Science, and *Aspergillus oryzae* was designated a national microbe. National flowers and birds are quite common, but a national microbe is the first of its kind in the world. In 2012, India designated *Lactobacillus bulgaricus* used for making yogurt as a national microbe. In 2013, the US state of Oregon designated *Saccharomyces cerevisiae* as a state microbe.

Now, where does *koji* mold used for sake brewing come from? Genome analysis of various molds indicates that *A. oryzae* is considered to be a domesticated microorganism from *A. flavus*. The genome sequence of *A. oryzae* closely resembles that of *A. flavus* (98% or more) but differ in the following respects. For instance, *A. oryzae* has three α -amylase genes while *A. flavus* has one. Conidia (spores) of *A. oryzae* are multinucleate with three to five nuclei, but those of *A. flavus* are uninucleate. Conidiation of *A. oryzae* occurs under dark condition whereas *A. flavus* under light condition. Moreover, it is found that *A. flavus* produces a fungal toxin, aflatoxin while genes for aflatoxin production of *A. oryzae* are missing. It has long been known that *koji* mold does not produce aflatoxin. The genome information also confirmed its safety.

Based on the above, *koji* mold is said to be a microorganism domesticated by Japanese. A typical example of domesticated microorganisms is beer yeast. Recently some people consider cultivation and domestication as a form of co-evolution of plants and animals with humans. Based on such concept, we can call *koji* mold co-evolved microorganism.

8) Closing

Let’s think about the economic impact of inscription on the UNESCO Intangible Cultural Heritage list and potential of *koji* mold in near future.

The inscription of washoku as a UNESCO Intangible Cultural Heritage in 2013 brought about effects such as a significant increase in the number of Japanese restaurants abroad and a rise in the export of Japanese food, including sake. According to a survey by the Japan Tourism Agency, it is Japanese meals that overseas tourists look forward to most on trips to Japan. This indicates that the recent inscription is expected to boost not only the export of sake and *shochu* further but also sake brewing overseas, which is beginning to increase.

Japan has seen a significant increase in the export of sake in recent years. Total exports in FY2022 reached 47.4 billion yen, surpassing the previous year for 13 straight years. The export in quantity is a record high of 35,895 kiloliters.

Production of sake overseas is also increasing. On the West Coast, Ozeki Sake USA, Inc. (founded in 1979), Takara Sake USA Inc. (1983), Gekkeikan Sake (USA), Inc. (1989), SakeOne Corporation (1997), and Yaegaki Corp. of USA (1999) are producing sake. In 2023, Dassai established Dassai Blue Sake Brewery in New York State and started production. Sake is also made in Korea, Taiwan, Australia, and Vietnam.

In addition, more and more sake contests are being

held overseas. The one with the longest history is the US National Sake Appraisal—Joy of Sake, which has been held in Honolulu, Hawaii since 2001. The event is hosted by the International Sake Association, a non-profit organization established by sake lovers living in Hawaii. International Wine Challenge (IWC) set up in 1984 is one of the most prestigious blind tasting competitions in the world. The sake category was added in 2007. Kura Master started in Paris, France in 2017 with the judges are French and other European nationals. Sake Selection was established by Concours Mondial de Bruxelles (CMB) in 2018. Milano Sake Challenge launched in 2019 is held in Milan with the jury including Italian sommeliers.

There is also demand for tourism from overseas, the so-called inbound tourism, which is beginning to be recognized as one of key industries in Japan. The Japan Tourism Agency estimates that the number of inbound tourists will reach 40 million, exceeding expectations, in 2025. In 2030, the number is expected to climb to 60 million. Given that experiential tourism will become a dominant trend, the inscription on the heritage list may help attract more attention to tours of sake breweries across Japan. Luckily, we have more than 1,000 breweries across Japan from Hokkaido to Kyushu. While foreign tourists flocking Kyoto and Mt. Fuji are causing overtourism, sake brewery tourism will greatly help revitalize regions struggling with population decline. The inscription may not simply boost the consumption of traditional sake but also lead to rural revitalization.

Lastly, as potential of *koji* mold, mycoproteins (alternative protein derived from fungi) are in the spotlight. *Koji* Labo, a startup founded in 2024 by associate professor Daisuke Hagiwara at the University of Tsukuba, develops *koji*-derived alternative meat and protein. At Agro Ludens, a startup established in 2021, Kiyotaka Saga, former assistant professor at the University of Tokyo, develops alternative meat and protein from *koji* mold. Agro Ludens and Otafuku Sauce started production of mycoproteins, and dishes using their products (e.g., Mapo Tofu bowl and Xian Dou Jiang noodles) were served at the campus cafeteria of Tokyo University as part of Sustainability Week 2025 in June 2025 (Figure 6). It is also said that Hieizan Enryakuji is developing the modern version of Buddhist vegetarian cuisine, *modoki ryori* (imitation dishes), using *koji*-derived mycoproteins. *Koji* mold used for sake brewing for a long time is now expected to be leveraged in various other fields.

This article is a summary of a lecture on “Japanese traditional sake brewing inscribed as a UNESCO Intangible Cultural Heritage—Functions and importance of *koji* mold” on the Kikkoman food culture course held on October 25, 2025. At that occasion, we invited the participants to make *koji amazake* and *shiokoji* and taste them. Figure 7 shows the recipes used then.

On December 20, 2025, a program called “Sake Truth” about the history of sake brewing (Host: Chris Glenn and Guests: Katsuhiko Kitamoto, Koshin Ohara (Abbot of Shoryakuji), etc.) was broadcast on NHK World. This is available to watch by video on demand (Sake Truth - Time and tide | NHK World-Japan). This can be also another effect of the inscription on the UNESCO Intangible Cultural Heritage list.



Figure 6. Dishes using *koji*-derived mycoproteins served at the University of Tokyo Co-op.

Recipe for *Koji amazake*

Add 300 ml of hot water (55 to 60°C) to 300 g of rice *koji* and mix. Keep the mixture warm for five to ten hours.

(Finished *amazake* will keep for about a week in the fridge if heated before storage. This, however, will inactivate the enzyme. Most commercially available *amazake* is heated for sterilization.)

Recipe for *shiokoji*

300 g *koji* (250 g dry *koji*)

100 g salt (100 g for dry *koji*)

400 ml water (450 ml for dry *koji*)

(The perfect ratio of handmade *shiokoji* is 3:1:4. Source: *Kojiya Honten* website)

1. Place *koji* in a clean storage container.
2. Put salt on the *koji* and pour water.
3. Stir thoroughly using a clean spoon.
4. Place a cover and store in a clean place at room temperature and low humidity.
5. Stir thoroughly with a clean spoon every one or two days.
6. If it has thickened, stir every two to three days. It will be finished in 10 to 14 days.

Figure 7. Recipes for *amazake* and *shiokoji*

References

- Katsuhiko Kitamoto, *Mystery of washoku and umami—a 1000-year story woven by Japanese koji mold, Aspergillus oryzae*, Kawade Shobo Shinsha (2016)
- Katsuhiko Kitamoto, Roles and importance of *koji* in sake brewing, monthly magazine *Cultural Properties* (special feature on traditional sake brewing in July 2025 issue)
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Katsuobushi dashi (Dried Bonite Broth) that enriches the Edo period cuisine

Nozomu Oginome

Introduction

At the press conference in January 2026, the Minister of Land, Infrastructure, Transport and Tourism announced that the number of overseas tourists visiting Japan in 2025 reached a record high of 42.7 million. A survey on consumption trends of inbound tourists shows that food and beverage expenses are ranked second. Washoku, which interests those tourists, is greatly based on the food culture in the Edo period.⁽¹⁾

Washoku developed in the Edo period for three reasons.

- (1) Pursuit of sophisticated taste by *ryotei* (traditional fine-dining restaurants) focusing on drinking parties (e.g., Momokawa in Nihonbashi, Yaozen in Asakusa, and Hirasei in Fukagawa)
- (2) Development and spread of Koikuchi Shoyu (standard soy sauce) and sweeteners such as sugar and *mirin*
- (3) Completion of *katsuobushi* (dried bonito or skipjack tuna) production method and improvement in quality of *katsuobushi dashi* (broth)

This article will mainly discuss (premium fully-aged *katsuobushi*) completed as improved *Izubushi* in the late Edo period.⁽²⁾

1. History of *katsuobushi*

Along the Japanese coast, *katsuo* (bonito or skipjack tuna) are caught twice a year: in spring when the schools first arrive from the southeast (*hatsugatsuo* — the first catch), and in autumn as they return to their spawning grounds (*modorigatsuo* — the returning catch).

(1) Relationship between *katsuo* and Japanese

Many *katsuo* bones have been unearthed in shell mounds of the Jomon period (14,000–300 BCE) on the coast along the Japan Current. In the north, *katsuo* bones have been also found in archaeological sites around Hachinohe, Aomori.⁽²⁾



Nozomu Oginome

Graduated from the Department of Fisheries, School of Marine Science and Technology, Tokai University. After joining Ninben Co., Ltd., he engaged in analysis and safety assessment of *katsuobushi* and new products, basic improvement research of *katsuobushi* and flakes, and applied research of beneficial *katsuobushi* molds at the R&D department. Engaged in development of new seasonings. Chief engineer in quality control and sterilization control. Took office as executive

officer, head of R&D Department in 2003 and left office in March 2012. Left the company in March 2026. Organized *katsuobushi* food education class for young children to adults. Former director of the Japan Soy sauce Technology Center, former Japan *Katsuobushi* Association expert member.

During the Ritsuryo period (late 7th c to 10th c), processed products, *katsuo* (dried), *nikatsuo*, and *katsuoirori* (*), were sent to the capital from production areas as *cho* (tax) and presented as offerings to deities, emperor, and aristocrats. *Katsuo* (dried) is raw *katsuo* cut into fillets and sun-dried. *Nikatsuo* is sun-dried *namari* (boiled *katsuo*). *Katsuoirori* is a concentrate made from *namari* broth. No recipes have been found in contemporary literature. Researchers in many different fields are jointly studying them.⁽⁴⁾

In *katsuobushi* production process, the crucial part is *kunkan* (smoke-drying) in which *namari* is dried with smoke of burning hardwood logs and high temperature heat. One of the aims of *kunkan* is to prevent initial rot by bacteria. This step is called *baikan* (smoke-drying).

(* This bonito was used for infusing soups, and we might consider this a precursor to *katsuobushi*, the bonito flakes used in making dashi today. This bonito was dashi today. This bonito was likely treated with salt and dried until hard.

(2) Where does *kunkan* come from?

Is *kunkan* an indigenous technique of Japan? According to the most prevailing theory, the technique comes from Maldives, an island country in the Indian Ocean 7,000 km away from Japan. A Moroccan travel writer Ibn Battūta, who visited Maldives in 1343, reported that the country exported *katsuobushi* (*katsuo* was locally called rainbow trout) to India, Ceylon (Sri Lanka), China, Yaman (Yemen), and Malacca Sultanate (a sultanate that used to be located near Malaysia). Ryukyu Kingdom was trading with Malacca Sultanate. The theory suggests that the *kunkan* technique was brought to Japan via Ryukyu.⁽⁵⁾

Others argue that there is little relevance, claiming that many other places on the route were rich in *katsuo* and that there is no evidence *katsuobushi* was made in the country. Yet another theory suggests that production of *katsuobushi* began in the two countries independently of each other. I believe doing *kunkan* is meant for hygiene and pest control when trying to reproduce *katsuo* (dried) and *nikatsuo*.⁽⁶⁾

(3) *Katsuobushi* culture that flourished in the Edo period

The base of present *katsuobushi* production process was established during the 270 years (1603-1867) of the Edo period. By the late Muromachi period, *katsuo arabushi* made by fire drying, the predecessor of the *baikan* technique, was considered to exist.⁽⁵⁾ In the early Edo period (*1), *katsuo arabushi* made by *baikan* began to be sold in the quantity as much as the business was profitable. This seems to be likely considering the year of establishment of Ninben (1699, the early Edo period) when it was already trading *katsuobushi*. *Shokoku*

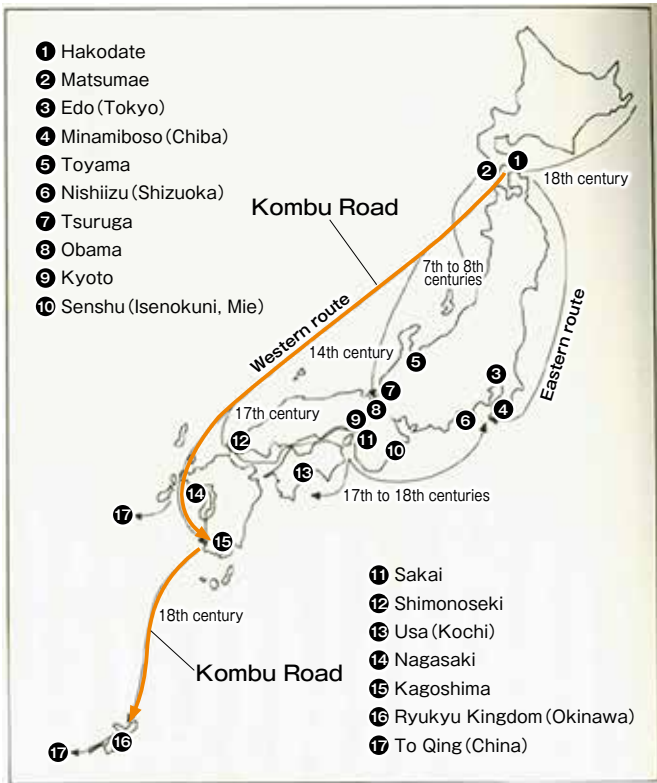


Figure 2. Western route, eastern route, and kombu road (source: *Shitte Okitai Washoku no Bunka* edited by Yo-ichiro Sato, Benseisha Publishing (2022), with several modifications) ⁽⁷⁾

- Although *kombu* should be exported to Qing China via Dejima in Nagasaki, Satsuma Han (domain) exported as herbal medicine via Bonotsu Port and imported herbs from which Chinese medicine was made. Some point out that the profits gained in this way funded the overthrow of the shogunate. ⁽⁸⁾
- This illegal trade was later found out by the shogunate, which led to a major incident known as *Karamono-kuzure* (collapse of import from China). Merchant ships fleeing from Bonotsu to nearby Makurazaki were used as *katsuo* fishing boats and Makurazaki grew into a major landing port of *katsuo*. ^{(5) (8)}

Table 1 shows the top 15 prefectures in the number of temples per 100,000 people. Among them, 12 prefectures belong to Western Japan. The table also lists the *kombu* purchase quantity and amount in the capital of each prefecture. The number in parentheses is the rank among 52 cities surveyed.

Unlike *katsuobushi*, types of preferred *kombu* vary from region to region and prices vary with the type. If including the capitals with purchase quantity and amount above national average, the table indicates that the proportion of temples in Western prefectures correlates with either *kombu* purchase quantity or amount or both.

2. How *katsuo honkarebushi* is made from *katsuo*

Figure 3 shows the production process of *katsuo honkarebushi*. This production process is the result of the predecessors' efforts and wisdom on how to improve the shelf life and flavor while reducing moisture in *katsuo*.

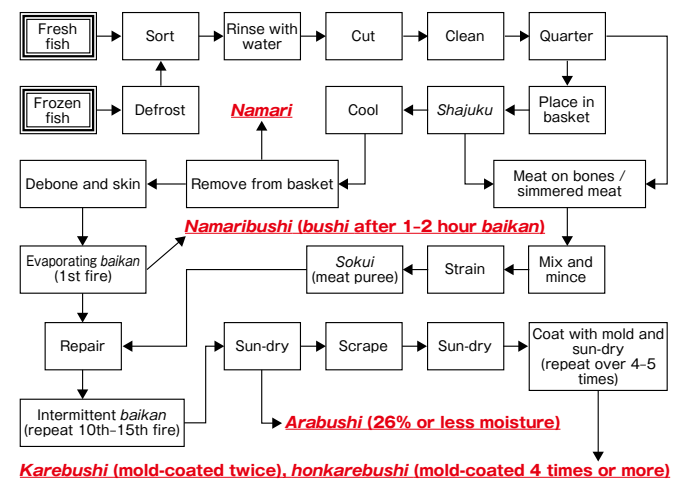


Figure 3. From *katsuo* to *katsuo honkarebushi*

Table 1. Number of temples per 100,000 people and *kombu* purchase quantity and amount by prefecture

Ranking	Temple (organization/corporation)			Kombu		
	Prefecture	Total	per 100,000 people	City	Purchase quantity	Purchase amount
	National average	76,634	61.3	National average	214	798
1	Shimane	1,292	237.7	Matsue	335 (4)	962 (12)
2	Shiga	3,204	227.3	Otsu	232 (16)	1,170 (5)
3	Fukui	1,672	222.1	Fukui	320 (6)	1,478 (2)
4	Yamanashi	1,484	185.1	Kofu	154 (40)	578 (46)
5	Wakayama	1,585	175.5	Wakayama	113 (52)	650 (39)
6	Toyama	1,521	149.7	Toyama	330 (5)	1,663 (1)
7	Yamagata	1,477	141.9	Yamagata	420 (3)	1,222 (4)
8	Nara	1,803	138.1	Nara	172 (34)	890 (7)
9	Mie	2,347	134.7	Tsu	217 (22)	629 (42)
10	Saga	1,069	133.5	Saga	150 (43)	670 (7)
11	Niigata	2,755	128.0	Niigata	296 (9)	783 (25)
12	Ishikawa	1,352	120.9	Kanazawa	232 (17)	984 (10)
13	Kyoto	3,051	119.6	Kyoto	167 (37)	1,014 (9)
14	Oita	1,236	111.7	Oita	227 (20)	739 (31)
15	Yamaguchi	1,418	108.0	Yamaguchi	147 (45)	678 (36)

Note: Sakata in Yamagata, Niigata and Teradomari in Niigata, Akamagaseki (Shimonoseki) and Mitajiri in Yamaguchi were main ports of call of *kitamaebune*.

Photo 1 shows *katsuo* fillets (for *honbushi*) and finished *katsuo honkarebushi*. It takes about four to six months to make *katsuo honkarebushi* when 4.5-kg raw *katsuo* is used.



Photo 1. Comparison of raw *katsuo* fillets and *honkarebushi*



Changes in weight yield
Katsuo: 100%
 Portion used: 75%
Namaribushi: 50%
Arabushi: 22%
Honkarebushi: 15%

Katsuo: weight of approx. 6.0 kg with 70% moisture



Katsuo arabushi
 Weight: approx. 1,300g/4 pieces
 Moisture: approx. 24%



Katsuo honkarebushi
 Weight: approx. 900g/4 pieces
 Moisture: approx. 15%

Figure 4. Yield changes from *katsuo* to *katsuo honkarebushi*

Figure 4 shows changes in weight of raw *katsuo* cut into fillets → *namari* → *arabushi* → *honkarebushi*. Yield in proportion to raw *katsuo* is reduced from 1/5 of *arabushi* to 1/6 of *honkarebushi*. In other words, a price rise in raw fish by 100 yen per kg equals a rise of 500 yen in *arabushi* and 600 yen in *honkarebushi*.

(1) After *katsuo* is filleted, *shajuku* is performed. The *shajuku* temperature needs adjustment according to the freshness and size of *katsuo*. When 4.5 kg or heavier *katsuo* is quartered (fillets for *honbushi*), they are placed into water at approx. 80°C, the temperature is raised to around 90°C, and the fillets are boiled for

90 minutes. *Shiagebushi*, which is *namari* made by *shajuku* and cooled, will be sold in the form of *bushi* (fillet) after skinning (partly leaving skin near the tail) and deboning. *Namaribushi* is *namari* subjected to *baikan* for two to three hours.

- (2) Early stages (1st to 3rd fire) of *baikan* (*3) involve drying using high-temperature smoke and hot air. *Baikan* is repeated continuously till the 5th to 6th fire. After that, *baikan* is performed not everyday but at intervals while the surface moisture of *bushi* fillets is checked. This is called intermittent *baikan*. When the moisture content is reduced to 26% or less, the *katsuo arabushi* is complete.
- (3) The surface of *katsuo arabushi* is covered with smoke components from *baikan*. Removing this surface layer by scraping with a grinder or a special knife and sun-drying once again result in *katsuo hadakabushi*. This scraping process ensures growth of beneficial *katsuobushi* mold on the surface.
- (4) A suspension of purely cultured beneficial *katsuobushi* mold is applied to *katsuo hadakabushi*. The *hadakabushi* is then placed in a mold coating chamber with temperature and humidity kept constant. This starts the fermentation process in which the moisture is reduced and the flavor is improved with the help of important microorganisms.
- (5) After the first mold coating, the *bushi* will be covered with well grown beneficial mold, then sun-dried for a day. This is the first mold-coated *bushi*.
- (6) The first mold-coated *bushi* is placed in the mold coating chamber again to grow the beneficial mold. This time, a mold suspension is not applied. The *bushi* with mold grown again is called the second mold-coated *bushi*. When the first khaki mold begins to turn brownish, the second mold coating is completed. The *bushi* is taken out from the mold coating chamber and sun-dried for a day. This completes the *katsuo karebushi*.

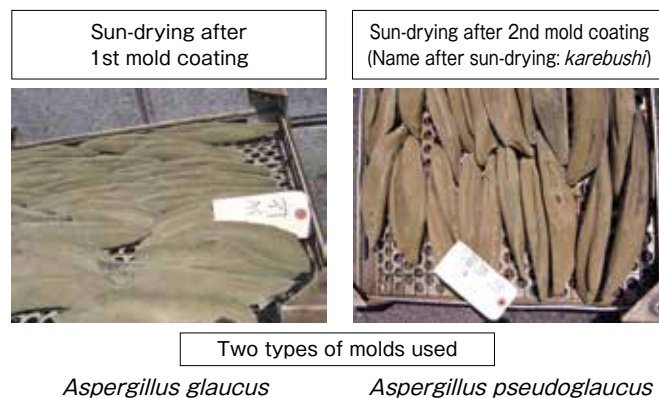


Photo 2. Changes in color tone from the first mold coating to the second mold coating

- (7) After the second mold coating finishes, the step (6) is repeated. Sun-dried *bushi* is now called the third mold-coated *bushi* and, after that, the fourth mold-coated *bushi*. After the fourth, we call *bushi* as *katsuo honkarebushi* at Ninben. *Katsuo honkarebushi* is not specified in detail by the Japanese Agricultural Standards (JAS). Individual companies use their own standards.

(*3) *Baikan* (smoke-drying)

- Day 1 of *baikan* is called the 1st fire (or evaporating *baikan*) and Day 2 the 2nd fire. When a Yaizu-style dryer is used, *baikan* is performed till 11th or 12th fire for total duration of approx. 80 hours. In a *kyuzokko* (drying tower for mass production), *baikan* is performed to 12th or 14th fire and the whole *baikan* process takes about 100 hours. A high fat content in *katsuo* slows moisture reduction and increases the *baikan* duration.
- Smoker fuels used for *baikan* are logs of well-dried oak, Japanese oak, konara oak, sawtooth oak, and other broadleaved trees. In the past, trees in local mountains were used, which gave distinct characteristics of each production area. Today, similar logs are used all over the country. The characteristics of *bushi* mainly come from difference of *baikan* facilities used.
- *Baikan* is a very important process in *katsuobushi* production. Not only it imparts smoky flavor to *katsuobushi* but also it is proven to provide diversified effects such as antioxidation, rot resistance at an early stage, and production of pyrazines by high temperature.

Photo 3. Various *baikan* systems

Tebiyama-style *baikan* method



Namari fillets are placed in steamers and put over a fire bed with burning logs to expose the fillets directly to smoke and hot air. This *baikan* method is considered to have been used since the early Meiji period (1868-1912). It is still used in several regions including Nishiizu and Ise.

Takinaya-style *baikan* tower



The tower is divided into five layers: *baikan* is started with fillets placed in the first layer, then they are moved away from fire to the second, then to the third layers, and finally to the fifth layer for adjustment.

Yaizu-style dryer (medium-scale *baikan* system)

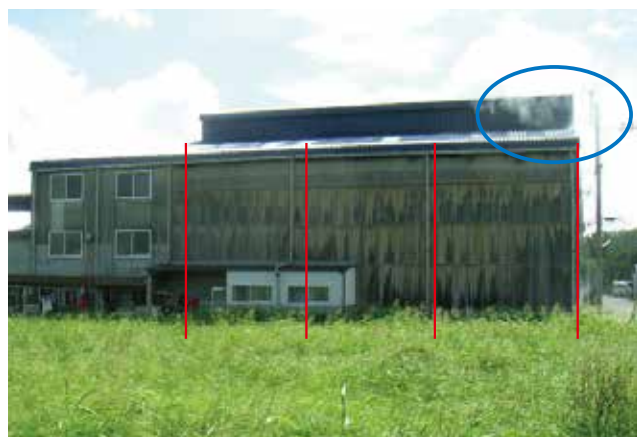


The fire bed is in the place marked with a red circle. Smoke and heat are sent by a fan into the *baikan* chamber with a blue circle mark.

Kyuzokko (drying tower for mass production)



Exterior of *kyuzokko*



It is a three-story building with a basement. Logs are burned in the basement and *baikan* is performed on the first, second, or third floor depending on how much *bushi* is dried. The *kyuzokko* shown in the photo is divided into three blocks (red lines) to adjust production. The rightmost block is in operation (blue circle mark).

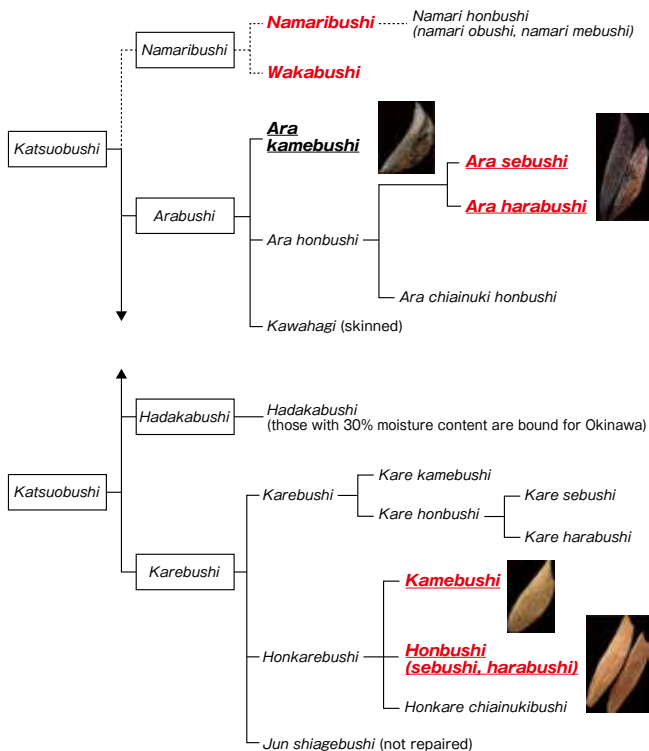


Figure 5. Types of *katsuobushi*

- *Katsuobushi* at different steps of production process is sold as different products.
 - These products are named in accordance with the rule of Japan Katsuobushi Association. Naming rule: Fish name (*katsuo* or *maguro*) + process + form. For example, if fish is *katsuo*, process is *ara*, and form is *honbushi*, it is called *katsuo arahonbushi*.
- Note: As is often the case with traditional food industries, people often follow the conventional business practices and it is difficult to collate *bushi*-related statistical figures.

3. Science of *katsuobushi*

(1) Fat content in *katsuo*

Katsuobushi is made only from *katsuo*. Not just any *katsuo* is suitable. If unsuitable *katsuo* is used, even if the production process shown in Figure 3 is implemented under perfect conditions, you won't get good quality *katsuobushi*. It is first necessary to select *katsuo* suitable for *katsuobushi*.

Except for premium products, most *katsuobushi* is made from frozen *katsuo* caught by overseas purse seiners in southern waters. FADs (fish aggregating devices) leveraging the behavior of *katsuo* and tuna ensure efficient fishing. However, there is a ban period for fishing using FADs for resource management of tuna. In 2026, FADs are prohibited for 1.5 months in the exclusive economic zone (EEZ) and for 2.5 months on the high seas. During these periods, overseas purse seiners target fatty *katsuo* in the deep sea and therefore fatty *katsuo* is mainly used for *katsuobushi*.

Not all *katsuo* caught in the seas around Japan is suitable as an ingredient of *katsuobushi*.

Table 2 shows the nutritional facts of *hatsugatsuo* and *modorigatsuo*, taken from the Standard Table of Food Composition in Japan (8th revised edition).⁽⁹⁾


Table 2. Comparison of nutritional facts between *katsuo* caught in spring and autumn

Food and description		<i>Katsuo</i> Caught in spring, raw	<i>Katsuo</i> Caught in autumn, raw	<i>Katsuobushi</i>	
Energy	kcal	108	150	332	
Water	g	72.2	67.3	15.2	
Protein	g	25.8	25.0	77.1	
Lipid	g	0.5	6.2	2.9	
Carbohydrate	g	0.1	0.2	0.8	
Ash	g	1.4	1.3	4.0	
Minerals	Sodium	mg	43	130	
	Potassium	mg	430	380	
	Calcium	mg	11	8	
	Magnesium	mg	42	38	
	Phosphorus	mg	280	260	
	Iron	mg	1.9	1.9	
	Zinc	mg	0.8	0.9	
	Copper	mg	0.11	0.10	
	Vitamins	Retinol	μg	5	20
		Carotene	μg	0	0
RAE		μg	5	20	
D		μg	4	9	
E		mg	0.3	0.10	
K		μg	(0)	(0)	
B1		mg	0.13	0.10	
B2		mg	0.17	0.16	
Niacin		mg	19.0	18.0	
B6		mg	0.76	0.76	
B12	μg	8.4	8.6		
Folate	μg	6	4		
Pantothenic acid	mg	0.70	0.61		
C	mg	Tr	Tr		
Fatty acids	Saturated	g	0.12	1.50	
	Monounsaturated	g	0.06	1.33	
	Polyunsaturated	g	0.19	1.84	
	Cholesterol	mg	60	58	
Salt equivalents	g	0.1	0.1		
Remarks		Aka: <i>Hatsugatsuo</i>	Aka: <i>Modorigatsuo</i>		

Fat content greatly influences *katsuobushi* quality. If *katsuobushi* has a high fat content, a phenomenon called *shirata* may occur. *Katsuobushi* with *shirata* is more likely to crumble when grated into flakes and the flakes are also likely to break into powder. In addition, a report reveals that *shirata* deteriorates the taste, makes *dashi* cloudy, and reduces the free amino acid content and inosinic acid content. Raw *katsuo* caught in autumn (*modorigatsuo*) has a high fat content of more than 6% and very likely to cause *shirata*. *Modorigatsuo* is delectable as sashimi and *tataki* (seared sashimi) but not fit for *katsuobushi*. In contrast, *katsuo* caught in spring (*hatsugatsuo*) has only a 0.5% fat content and suits *katsuobushi*.^(11, 12)

Table 3. Relationship between occurrence of *shirata* and fat content in the surface

Fat content in the surface (%)	Incidence of <i>shirata</i>
3.6	±
4.7	±
4.1	±
5.0	±
5.9	+
6.5	+
6.9	++
9.3	++
12.6	++



± : Rarely seen.
+ : Seen a little in the surface.
++ : Seen 1/2 to 1/3 of the whole.

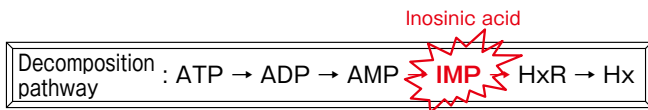
Fat in *katsuo* is mostly contained as subcutaneous fat and orbital fat and in stomach and intestines.⁽¹⁰⁾ When making *katsuobushi*, the head and innards are removed but subcutaneous fat cannot be removed completely even by *shajuku*. Residual fat makes moisture in *namari* hard to remove during *baikan* and hinders drying. When selecting *katsuobushi* in a store, check the skin left near the tail. Avoid *katsuobushi* with deeply wrinkled skin and choose ones with no or slight wrinkles.

(2) Changes in inosinic acid quantity

The main *umami* component of *katsuobushi* is inosinic acid. Production of inosinic acid is explained based on **Figure 6**.

ATP (adenosine triphosphate), which is energy currency used to move muscles, is decomposed rapidly by nuclease to ADP (adenosine diphosphate), then to AMP (adenosine monophosphate), and to IMP (inosine monophosphate or inosinic acid). Since the decomposition slows down after IMP, IMP accumulates in muscles. Over time, it is further broken down to inosine and then to hypoxanthine. Among these nucleic acid related substances, it is only IMP that has *umami*. Very fresh *katsuo* that has just been caught won't have much of its distinct *umami*. To make *katsuobushi* rich in inosinic acid, *katsuo* needs to be simmered (*shajuku*) when the accumulation of inosinic acid peaks. This inactivates nuclease and retains inosinic acid. It resembles the aging of tuna and beef.

Figure 6. Decomposition pathway of nucleic acid related substances



Therefore, *katsuo* for *katsuobushi* is selected, based on the operating area and characteristics of the fishing boat to place a bid for; the fattiness, freshness and size of sample *katsuo*; the flow of the Japan Current and water temperature distribution; information on future deep-sea fishing, fishing regulations (Western and Central Pacific Fisheries Commission (*4)), and price trends.

(*4) Western and Central Pacific Fisheries Commission (WCPFC) WCPFC is a regional fishery management organization for highly migratory fish stocks in Pacific Ocean west of 150°W including Japan in the northern hemisphere and west of 130°W, east of 141°E, and north of 60°S in the southern hemisphere. The fish stocks include bluefin tuna, bigeye tuna, skipjack tuna, yellowfin tuna, albacore, marlin, and marine sharks.

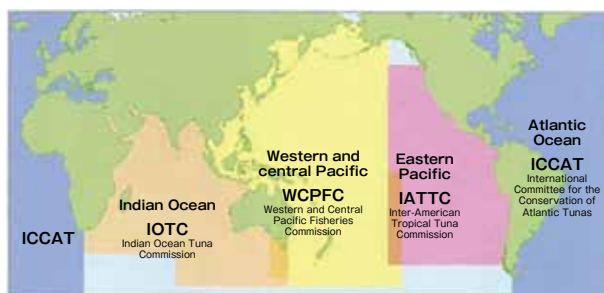


Figure 7. Regional fishery management organization for highly migratory fish stocks in each sea area

4. Science of dashi

Dashi omission test is a study to identify important components consisting of *katsuobushi dashi*. First, possible components of *katsuo honkarebushi dashi* (nitrogen-containing components: free amino acids, nucleic acid related substances (e.g., IMP), organic bases, and peptides, and nitrogen-free components: organic acids and sugars) are identified and analyzed. Using the resulting data, synthetic *katsuobushi dashi* is prepared. Each component is omitted from each group and the differences in taste indicate the key components.

The *dashi* omission test shows that *katsuobushi dashi* is made up of the following nine key components.

- Histidine, glutamic acid, inosinic acid, lactic acid, creatinine, inosine, hypoxanthine, sodium, and chlorine

The following table shows how the tastes changed when each of the components was omitted. Each taste is marked with + when slightly enhanced and ++ when greatly enhanced for each component. They are also marked – when slightly reduced and – – when greatly reduced. The representative *umami* of *katsuobushi dashi* is said to be inosinic acid. But eight other components are also playing an important supporting role.⁽¹⁴⁾

Table 4. Components necessary for the taste of *katsuobushi dashi*

Omitted components		(mg./100ml)	
1. Tau	1	10	Val 0.5
2. Gly	0.8		Ile 0.3
3. Ala	1		Phe 0.5
4. His	62.3		Trp 0.1
5. Asp	0.06		Orn 0.2
6. Glu	0.7		Arg 0.2
7. Leu	0.8	11. Ans	39.1
8. Lys	0.9	12. Car	3.3
9. Met	0.5	13. TMA	0.6
thr	0.3		TMO 0.2
Ser	0.4	14. Cre	15.9
Pro	0.2	15. Crn	35.9
		16. AMP	1.6
		17. IMP	14.8
		18. Ino	5.8
		19. Hx	0.4
		19. Sugars	
		20. Lactate	106.7
		21. Other organic acids	
		22. Na	13.6
		23. K	21.5
		24. Mg	17.0
		25. P04	17.0
		26. Cl	50.0

Taste changes

	Sweetness	Acidity	Saltiness	Umami	Persistence	Richness	Smoothness
Glu	+			++	+	+	+
Na			+			+	
Cl				+	+	+	+
IMP			+	++	++	++	+
Lactic acid		++					
His		++		+			
Crn				–			– –
Ino+Hx							
Lys							
Car							
K				+		+	

+:Slightly enhanced ++:Greatly enhanced –:Slightly reduced – –:Greatly reduced

As to the salt reduction effect of *katsuobushi* discussed below, the studies for selection of relevant components were started based on this omission test result.

5. Science of *katsuobushi dashi* making

Soft water is used to make *katsuobushi dashi* just like *kombu dashi*. Tap water contains chlorine for hygienic reasons. It is recommended that tap water should be dechlorinated with a home water purifier.

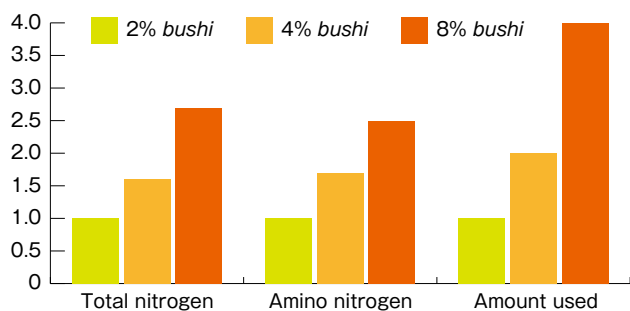
It is also recommended that soft water should be used. Hard water does not suit the aroma and taste of *dashi*.

When making *dashi* using *katsuobushi*, the extraction efficiency of *dashi* components varies with the amount and thickness (*5) of flakes used. The extraction efficiencies were obtained by examining the extracted components (total nitrogen and amino nitrogen) in *dashi*.

(*5) JAS specifies that thin flakes are 0.2 mm or less and thick flakes are over 0.2 mm in thickness.

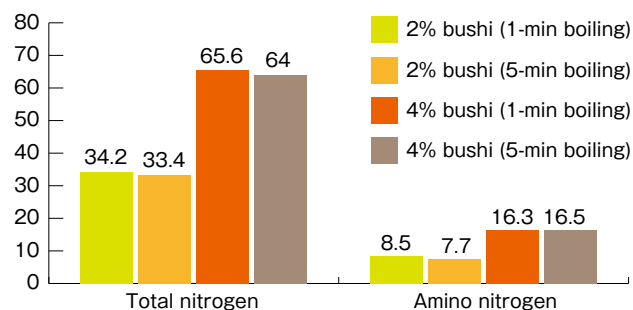
(1) Ratio of *katsuobushi* flakes to water for highly efficient *dashi* making

Refer to Figure 8. The test was performed using 2% (base), 4% (twofold) and 8% (fourfold) *katsuobushi* flakes. The result indicates that total nitrogen and amino nitrogen didn't increase twofold or fourfold. This means *dashi* components remain in the used flakes. You should make second *dashi*.⁽¹⁶⁾



Extraction conditions: Heat 1 min, leave to stand 3 min, and filter.

Figure 8. Changes in extraction efficiency by difference in amount of *katsuobushi* flakes



Unit: mg/100 ml

Figure 9. Difference in extraction efficiency by difference in *dashi* making time

There is no difference in extraction of *dashi* components whether between 1 min and 5 min. 1 min is long enough to make *dashi*.⁽¹⁶⁾

Dashi yield varies between summer and winter and with pan size and type of stove (gas and induction). Therefore, we recommend the following methods to make quality *dashi* with high extraction efficiency, constant yield, and little cloudiness.

(1) Making the first *dashi*

- When water in the pan comes to boil, turn off the heat.
- Put thin flakes of *katsuobushi* at 3% of water and leave it to stand for one or two minutes.
- Spread gauze or paper towel on a sieve, strain flakes, and leave to stand for one minute.
- Do not squeeze the flakes.

(2) Making the second *dashi*

- Place the used flakes in a pan and add water half that used in making the first *dashi*.
- After it begins to boil, simmer on low heat for three to five minutes, and turn off the heat.
- Add 1/6 of new flakes used for the first *dashi* and leave to stand for one or two minutes.
- Spread gauze or paper towel on a sieve and strain flakes.
- Lightly squeeze the flakes.

* Adding new flakes is called *oigatsuo* in culinary science. This enhances the aroma of the second *dashi*.

(3) *Dashi* making time by flake thickness

Sometimes, strong *dashi* is needed, for instance, to make dipping sauce for *soba* noodles. Using thin flakes, the required quantity may be so large that flakes may not be well soaked in water. In that case, use thick flakes.

Thick flakes are generally 0.8 to 1.0 mm in thickness. They are four to five times as thick as common thin flakes. To ensure high extraction efficiency, it is necessary to add flakes while the water is boiling, adjust the heat, and keep it gently boiling for 40 to 50 minutes.⁽¹⁷⁾

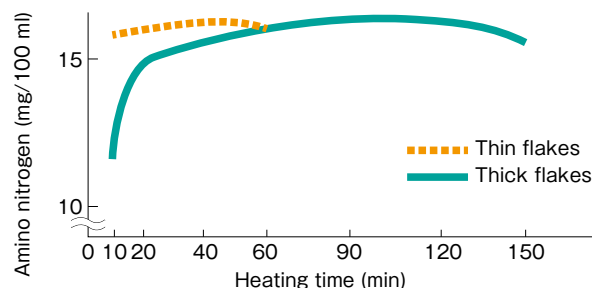


Figure 10. Changes in amino nitrogen in common thick flakes

Note: The thickness varies from manufacturer to manufacturer. Ask the manufacturer.

• Because it takes longer to make *dashi* using thick flakes, amino acid reacts with sugar in *dashi* and the Maillard reaction produces browning substance (melanoidin). Some experts believe that this substance imparts richness. The same effect may occur to *soba* sauce base in *dotanpo* (*6) passed down from generation to generation for tens of years at a long-established *soba* restaurant.

(*6) *Dotanpo* is a ceramic container used to heat *soba* dipping sauce in a bain-marie. In the past, most *dotanpo* was made of unglazed ceramics.⁽¹⁸⁾

6. Science of *katsuobushi* flakes

The expiration period (best-by) of *katsuobushi* is two years when kept in a package and one year after the package is opened. But, after processed into flakes, the

aroma fades and off-odor components are produced rapidly in several days. This is caused by many reactions such as:

- Production of off-odor components including linear aldehydes due to lipid oxidation and degradation
- Dissipation of beneficial volatile components (*7)
- Reduction of hydrogen sulfide by oxidation and change to sulfur⁽¹⁵⁾

(*7) *Katsuobushi* is said to have more than 400 types of aroma components. Many beneficial aroma components evaporate at low boiling points⁽¹³⁾

<Storage of *katsuobushi* flakes after package is opened>

After the package is opened, it is ideal to use it up. However, some flakes come in large bags.

- Remove the air inside the bag as much as possible. (If it is a zipper bag, remove the air in the bag and close the zipper.)
- Avoid intense light and store it in a fridge. Do not store in a freezer.⁽¹⁵⁾

7. Intriguing power of *katsuobushi* and *katsuobushi dashi*

Food serves various functions. Primarily it provides nutritional components essential to life, then pleases the palate, and lastly adjusts the functions of the body. This section mainly discusses the functions to please the palate.

- (1) Adhesion of bitterness by *katsuobushi* flakes
 - The bitter substances of bitter melon are triterpenoids. *Katsuobushi* flakes adhere these triterpenoids. In stomach acids, triterpenoids are released from the flakes.⁽¹⁹⁾
- (2) Antioxidant effect of *katsuobushi dashi* in cooking
 - When *katsuo dashi* was used for simmered sardines, the fishy smell was reduced. The DPPH radical scavenging activity of the broth increased and the TBA value of sardines fell.⁽²⁰⁾
- (3) Reduction in acidity and acidic smell by addition of *katsuo dashi*
 - The acidity of lactic acid and the acidic smell of acetic acid decreased in proportion to the amount of *katsuo dashi* added. Acetic acids derived from aroma components in a dressing and mayonnaise were reduced by 71% and 83%, respectively.⁽²¹⁾
- (4) Improvement to salty taste preference and enhancement of saltiness by *katsuo dashi*⁽²²⁾⁽²³⁾
 - The aroma of *katsuo dashi* has an effect of increasing preference for a low-salt saline solution.
 - *Umami* of *katsuo dashi* has an effect of increasing preference for a low-salt diet.
 - Histidine contained in *katsuo dashi* has an effect of enhancing salty taste.

These three effects of salty taste improvement indicate that using *katsuo dashi* may help extend health life expectancy in Japan, where the population is rapidly aging.

8. Closing

There are many research reports about physiological functions of *katsuobushi dashi*. They are published in the literature⁽²⁴⁾ below.

<Expected effects on human body>

- Alleviate fatigue (mental and physical).
- Control high blood pressure.
- Slow gastric emptying, which helps you feel full longer.
- Facilitate stomach movement.
- Stimulate salivary secretion.
- Alleviate hunger and increase satiety.
- Increase brain activation.
- Suppress fat intake and calorie intake.

<Expected effects on the state of mind and emotional behavior>

- Improve mood and emotional state (especially feeling of fatigue).
- Decrease aggressive behavior.
- Reduce depressive-like behavior.
- Reduce anxiety-like behavior.

We hope the research will progress further.

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Activity report of the Kikkoman Institute for International Food Culture

—Themed collection exhibitions “History of advertising of Kikkoman”

Masayoshi Shinozaki, Kikkoman Institute for International Food Culture

Kikkoman Institute for International Food Culture has been organizing themed collection exhibitions since 2024 to display exhibits selected according to different themes from the institute’s huge collections gathered and maintained for years. These exhibitions display carefully selected collections usually not open to the public that fit each theme. Based on the historical background and the social environment surrounding businesses, the exhibitions present the history and significance of the exhibits. This, we hope, will communicate the visions of business activities of the times to people today.

Table 1 shows the themed collection exhibitions held as of March 2026.

This article gives an overview of “History of advertising of Kikkoman—1920s to 1960s, a period of turbulence” and “History of advertising of Kikkoman II—Pure and Natural, 1968 to 1984.”

Themed collection exhibition, “History of advertising of Kikkoman

—1920s to 1960s, a period of turbulence”

This exhibition features advertising during a period from the establishment of Noda Shoyu Co. Ltd. (present Kikkoman Corporation) in 1917 to 1960s. The exhibits are divided into six periods according to themes focused by the ads. Among those periods, four periods are introduced below.

(1) Brand communication period

Ad of 1933. Noda Shoyu had 211 trademarks when established. Among them, the company chose Kikkoman, highly recognized at home and abroad as its brand, and expanded sales channels across the country. The ads of those days were aimed at promoting the Kikkoman brand. What is characteristic is that the hexagon logo is highlighted.



(2) Post-war period

Ad of 1950. Due to the wartime regulations and the rationing that continued even after the war, no advertisements were made for 10 years until soy sauce sales were liberalized again in October 1950. The impact of the long blank period was serious. According to a consumer survey in 1949, about 63% of women aged between 10 and 29 didn’t know of Kikkoman brand, indicating a drastic decline in the awareness.



To overcome the situation, the brand character Noda Kikko was created. In January 1950, before the free marketing of soy sauce was resumed, the character was placed in an ad of Worcestershire sauce to attract young generations and boost brand recognition. As a result, the character was widely known as Kikko-chan and she played an important role in Kikkoman advertisement till the 1970s.

(3) Period of focusing on quality and culinary

Ad of 1958. *Komi* (Aroma and Taste) is a word expressing the features of brewed soy sauce only Kikkoman could offer. As the brand recognition increased, the ads began to bring the quality of Kikkoman soy sauce to the fore and came to emphasize the combination of home cooking and Kikkoman.



Table 1. List of themed collection exhibitions held in FY2024 to FY2025

Type of exhibition	Period	Theme
Themed	July 8 to September 20, 2024	Soy sauce brewing then and now—from Meiji to Showa, evolution of tools
Themed collection	March 3 to May 30, 2025	History of advertising of Kikkoman—1920s to 1960s, a period of turbulence
Themed collection	July 29 to October 3, 2025	History of advertising of Kikkoman II—Pure and Natural, 1968 to 1984
Themed collection	January 13 to April 24, 2026	Kikkoman and world expositions—19th to 21st centuries

The “Soy sauce brewing then and now—from Meiji to Showa, evolution of tools” exhibition was held as a pilot initiative to themed collection exhibitions.

(4) Period of focusing on Western cuisine

Ad of 1962. In the 1960s, the Japanese diet was rapidly westernized. With confidence gained in the full-fledged expansion into the US in the 1950s, the company used the slogan “Kikkoman even for frying-pan cooking” to show that soy sauce would go well with not only Japanese cuisine but also Western dishes and emphasize that the use of soy sauce was not limited to Japanese cuisine.

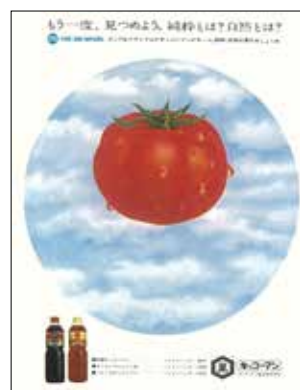


Themed collection exhibition, “History of advertising of Kikkoman II —Pure and Natural, 1968 to 1984”

This exhibition featured adverts from the late 1960s to the mid 1980s. In the 1960s, pollutions and various other problems related to the safety of food and medicines occurred one after another and concerns mounted about food safety. Under these circumstances, Kikkoman declared “Pure and Natural (P&N)” in the new year newspaper ad in 1969 to state its commitment to delivering pure and natural products. The advertisements of this period were divided into nine series according to the themes. This article discusses three of those series.

(1) Pure and Natural (P&N) declaration ad series

The ads of 1970 (left) and 1971 (right). The most important initiative in the product development in line with the P&N declaration was returning to *honjozo* (authentic brewing) about all the soy sauce as well as making them preservative-free P (Pure) soy sauce. The P&N series ads are designed with bold layout of food illustrations to emphasize enjoying food of the season.



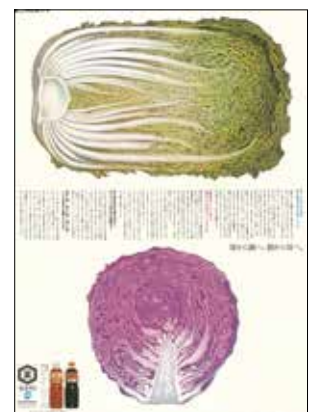
(2) Dialogue with consumers series

Newspaper ad of 1969. The company invited recipes using soy sauce from consumers and introduced some of the family recipes on ads. This changed advertisements from one-way transmission from manufacturers to a place for exchange of practical daily life information by allowing consumers participation.



(3) Mother-daughter taste dialogue series

Ad of 1972. The dialogue with consumers was evolved into mother-daughter dialogue. Through the dialogue between mothers of two different generations, the ad expressed changes over time reflected by cooking methods and family structures. In this series, a consumer participation campaign was also mounted. Recipe ideas from consumers reached about 90,000.



These two themed exhibitions demonstrate that Kikkoman has quickly perceived changes in the times and launched flexible and diverse advertising campaigns. It was significant in researching food culture and sharing the findings to look back the evolution of our advertisement from those aimed at improving brand recognition, to those focusing on quality, then culinary, and to ads consumers could relate to.

<https://www.kikkoman.com/en/kiifc/>

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Kikkoman Institute for International Food Culture

The Kikkoman Institute for International Food Culture has been engaged in research, cultural and social activities, and the collection and publication of information, primarily focusing on soy sauce - a fermented seasoning. Besides the exhibition of historical materials, the company's history and evolution of soy sauce are displayed in the form of a digital timeline here. Books related to foods and food cultures in the collection are also available for the public to browse. Books in the collection can be searched and the digital timeline can be seen on the website.



Permanent Exhibition



Exterior



Entrance



Library Corner



Reading Corner



Themed Exhibition



Food culture seminar



Permanent Exhibition



Permanent Exhibition



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Kikkoman Institute for International Food Culture

250 Noda, Noda-shi, Chiba-ken 278-8601, Japan TEL: +81-4-7123-5215 FAX: +81-4-7123-5218

Hours: 10:00 a.m. -12:00 a.m., 1:00 p.m. -4:00 p.m. Monday through Friday

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