

Nationwide Survey on Numbers of Wooden Barrels for Soy Sauce Production (FY2020[※])

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醤油製造用木桶保有数の全国調査 2020

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Summary

From 2019 to 2020, we conducted a questionnaire survey through the National Federation of Soy Sauce Industry Cooperatives and received responses from 459 soy sauce manufacturers. The results showed that 281 companies owned a total of 6,731 wooden barrels: 4,765 used for soy sauce production, 1,261 unused items, and 705 unusable items. (This is the translation of a paper originally published in Japanese in Journal of Soy Sauce Research and Technology, 47(3), 2021).

抄 録

2019–2020 年にかけて全国醤油工業協同組合連合会を通じてアンケート調査を実施し、醤油メーカー459社から回答を得た。その内281社が計6,731本(醤油製造に使用中4,765本, 不使用品1,261本, 使用不可納品705本)の木桶を保有していることがわかった。(本報告は『醤油の研究と技術』Vol.47, No.3, pp.141-150(2021)に掲載された論文を翻訳したものである)

INTRODUCTION

The 2013 registration of “Washoku, traditional dietary cultures of the Japanese, notably for the celebration of New Year” as UNESCO Intangible Cultural Heritage brought renewed attention to the features and uniqueness of Japan’s traditional food culture. Fermented seasonings such as soy sauce, miso, vinegar, and sake are particularly important elements of Japanese food culture.

Other Asian countries have their own salty seasonings made from soybeans and grains^{1,2}. Among them, while Japanese miso and soy sauce and Korean doenjang and ganjang, respectively, have similar

tastes and appearances, traditional production methods call for different raw materials and storage vessels. In Japan, koji is brewed in *kioke* wooden barrels, while in South Korea, *meju* is brewed in earthenware jars³.

In China and the Korean Peninsula, earthenware jars have been used in traditional production, with mass production achieved by increasing the number of jars. In contrast, in Japan, the sake and soy sauce brewing industries switched to large-capacity wooden barrels when they industrialized in the Edo period (1603-1867). Modernization of brewing equipment in the Taisho and Showa eras (1912–) that followed saw

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conversion from wooden barrels to vessels made of other materials, resulting over time in a lack of coopers to make new wooden barrels. And now the craftsmanship behind repairing old wooden barrels is also in danger of disappearing.

In April 2006, a meeting on the theme “Thinking about *Oke* [barrels] Late in the Game” (sponsored by the Wooden Barrels Preparation Preservation Society) was held in Roppongi, Tokyo. According to the record on sake brewing, as of 2000, there were virtually no brewers using wooden barrels, but by 2006, about 30 brewers around Japan had revived wooden barrel brewing⁴⁾. Some brewers take a negative view of wooden barrels because of difficult hygiene management and strict guidelines from the public health center. Other brewers see value in terms of unique flavor that outweighs any disadvantages, and they feel there is great value in passing on traditional brewing techniques to future generations. Currently, many sake brewers use barrels for one of their products, and some breweries especially in the Tohoku region have declared that all their products will be brewed in wooden barrels in the future. The tradition of brewing sake in barrels escaped the danger of disappearance around the year 2000, and new paths are constantly being sought.

There is a marked culture of wooden barrel brewing in the miso and soy sauce industries compared to sake, vinegar, and mirin. The true picture of wooden barrel use in the miso industry is unclear and will be an issue for future research, but in the soy sauce industry, there are still some brewers who make all their products in wooden barrels. We even learned of a young brewer who launched afresh into wooden barrel brewing from a desire to revive fermenting the mash in-house. However, no statistical data exists on the numbers of wooden barrels used by soy sauce makers nationwide, and the ratio of soy sauce prepared in wooden barrels to total production is unknown. Many of the wooden barrels currently used for soy sauce production were made some time in the first half of the 20th century, and most are nearing their end given a typical lifespan of 50 to 100 years. As with

sake brewing, efforts in the next few decades will determine whether scenes of rows of wooden barrels in Japanese soy sauce breweries will disappear, or if changing their scale and shape may help them survive.

Previous studies have yielded insufficient objective data to support the presence of unique taste and aroma components and microbiological peculiarities in soy sauce prepared in wooden barrels. In addition, we are yet to find research on taste preferences nor an experimental study comparing samples with all conditions held constant and the only variable being wooden barrel usage. The reasons include the fact that soy sauce has local characteristics^{5),6)} and that uniform comparisons are complicated by the array of applications of soy sauce as a basic seasoning with suitability changing depending on, for example, whether it is used as a dipping sauce or in cooking to flavor simmered dishes. In addition, there are great variations in the age and application of wooden barrels and conditions of the brewery itself. Preferences as to koji making method, preparation method, naturally occurring yeast in the brewery, and fermentation and aging conditions, among many other factors, also differ from brewer to brewer. It is commercially difficult for brewers to obtain samples of soy sauce brewed in large wooden barrels in a warehouse and soy sauce produced to the same scale and under all the same conditions except in vessels made of fiber-reinforced plastic (FRP) or some other material in order to compare them.

As such, this research on wooden barrels does not question the superiority or inferiority or pros and cons of wooden barrel usage in fermentation. Rather its purpose is to gain an accurate picture of wooden barrel usage for preservation and succession of Japan’s unique food culture and traditional production methods. It is positioned as the starting point for continuous tracking of fluctuations in the numbers of wooden barrels.

In this study, we seek to clarify the number and location of wooden barrels for soy sauce production as of 2019-2020 and the intentions of soy sauce brewers

who own the barrels regarding future increases and decreases.

CHANGES IN WOODEN BARREL USAGE AND TRENDS IN THE NUMBERS OF COOPERS

Below is a description of the connection between wooden vessels and Japanese soy sauce making, focusing on trends related to the coopers who construct them.

Fermentation and brewing technology in Japan began with the introduction of a seasoning product called hishio from the continent during the Nara period (710-794) by the envoy to Sui dynasty China. This was followed by the development of Japan's unique techniques for koji-making with seed koji. Until the Kamakura period (1185-1333), earthenware jars were the main vessels for fermentation and brewing as in the continent, but a shift occurred when wooden barrels became popular from the late 16th century and remained so through the 19th century.

Japan has a high forest rate of 67% (as of March 2017), and techniques for wooden buildings and woodwork using cypress and cedar timber have been developed over a long time. The technology for wooden barrel making is thought to have been introduced from both the Asian continent and Europe⁷⁾.

Until the 16th century, sake made at temples in Nara was considered premium sake, and based on a description in the *Tamonin Diary* (Tamonin Nikki) handed down by monks at Kofukuji Temple in Nara, “the existence of 10-koku (1.8 kL) barrels can be confirmed as of 1582.”⁸⁾ In the 17th century, the sake brewing industry in Itami and Ikeda near Osaka developed in great part thanks to abundant local supply of high-quality Yoshino cedar which was made into giant barrels with 1.8 kiloliter capacity. These enabled efficient preparation of the mash, and when the sake was transported, “because it was done so in sake barrels made from highly esteemed Yoshino cedar, sake from Osaka earned great fame in Edo”⁸⁾. Pictures of barrel-prepared sake brewing in Itami from that time can be seen in *Fujimi Sake in Itami, Illustration of Famous Places in Settsu, Osaka Vol. 6*⁹⁾.

In the 17th and early 18th century, large volumes of wooden barrels were placed on cargo vessels named Higaki Kaisen and later Taru Kaisen carrying sake and soy sauce from Osaka to Edo. The size of wooden barrels increased, and it is thought that “the basic shape for the 30-koku (5.4kL) barrels we see today was established in Nada before the Kansei era (1789-1801)”⁷⁾.

The appearance of wooden barrels and tubs as familiar tools in daily living is illustrated in a record of the customs of the late Edo period called *Morisada Manko*¹⁰⁾ and in ukiyo-e woodblock prints. One of the most famous of these is *Thirty-six Views of Mount Fuji, Bishu Fujimigahara* by Katsushika Hokusai depicting a cooper scraping the inside of a series of staves constructed into a rounded wooden barrel. In 1877, shortly after Edo became known as Tokyo, coopers accounted for “694 out of a total of approximately 54,000 households”, or “more than 1% of all households”¹¹⁾ in Tokyo. This shows how familiar wooden barrels and tubs were until the Meiji era (1868-1912).

In sake brewing, the mash prepared in winter is pressed in the spring, after which the wooden barrel is thoroughly washed and sun-dried throughout the rainy season and summer, a scene depicted in *Meiji Era Brewery*⁷⁾. As sake is brewed with fresh water, a thorough washing and drying process is repeated to prevent contamination by germs and the growth of mold. Wooden barrels are typically used for about 20 to 30 years in sake brewing, after which they are usually sold to soy sauce breweries, miso breweries, and pickle makers.

In contrast, soy sauce mash is prepared with salt water and aged for at least one year in the wooden barrel. Preparing the next mash immediately after pressing allows brewers to shorten the period during which the barrel is empty. For this reason, wooden barrels used in soy sauce production are said to last for 100-150 years, with very old barrels still in use today. In the meantime, as the modernization of brewing equipment progressed in the first half of the 20th century, many wooden barrels were discarded

and replaced with concrete tanks, and from the 1960s onwards with vessels made from other materials such as enamel, FRP, and stainless steel^{12, 13}. In recent years, there have been examples of super-large wooden tanks in use, but they are technically different from traditional bamboo-hooped wooden barrels¹⁴.

Wooden barrel craftsmen began to disappear with the sharp decline in demand for new barrels and repairs, such that now, without continuous transmission of the craft, only one cooperage remains – a place in Sakai, Osaka that repairs and manufactures large scale barrels. For soy sauce brewers who prepare mash in wooden barrels, the loss of the craftsmen's skills poses a major issue for both repairing barrels that begin to leak and procuring new barrels.

As of 2020, there were five developments in the field of wooden barrel making and repairs.

First, Mr. Takeshi Ueshiba of Fujii Seiokojo, who for about 10 years has been described as the last cooper in Japan, declared that he will no longer produce new barrels once 2020 orders are completed. The move apparently spurred many brewers to order new barrels and request reassembly of large barrels. Although new barrels will no longer be made, the business will continue to offer repairs and guidance on maintenance through brewery visits. The use of existing wooden barrels for as long as possible will require the brewers themselves to assume and pass on repair techniques.

Second, concern about a lack of coopers to make new barrels in the future motivated a soy sauce brewer and a group of carpenters from Shodoshima, Kagawa Prefecture to start the "Kioke Craftsmen Revival Project" and become apprentices to Mr. Ueshiba. Since 2012, a public event has been held in January every year to showcase the making of new barrels, and a system is being established to enable production of up to a dozen or so new barrels of 10 to 20-koku capacity (1.8-3.6 kL) each year. Also attracting attention is a new "Kioke Fermentation Culture Summit" (commonly known as the Kioke Summit) which first convened in January 2020,

gathering fermentation and brewing related people, coopers, and consumers and media interested in wooden barrels from all over the country.

The third development is the activities of the "Yuimono-de-Tsunagu-kai" centered on young coopers who have gone independent from the Shodoshima initiative and started visiting breweries to make new barrels or re-tighten the bamboo hoops of existing ones.

Fourth, sake brewers in Akita and Fukushima prefectures maintain contact with the Shodoshima revival project while also training their own craftsmen and cooperating with local coopers. Preparations are under way to start a barrel production and repair system.

Finally, there is a movement to introduce a new type of vessel to be used as large water tanks. The new variety is bound with a metal belt, and the shape is straight from the top to bottom without the gentle taper found in traditional bamboo-hooped wooden barrels. In addition, the position of the bottom plate and the construction for connecting the side plates is different from the wooden barrels made by a traditional craftsman, and the capacity is very large at 1,000-koku (180 kL) or more.

Here, it is necessary to confirm the meaning of the term *kioke*, typically translated into English as "wooden barrel or tub". The Japanese definition of *oke* or barrel is "a vessel made by arranging elongated plates vertically to make cylindrical siding, adding a base, and binding with hoops. Can also be made of metal. Mostly used to store liquids or make pickles."¹⁵ When made of wood (*ki*), it is a *kioke* wooden barrel – a word that refers to a fairly wide range of wooden vessels from sushi tubs to bathtubs and even coffins. Going forward, it will be necessary to distinguish between different types of wooden vessels, but as we did not separate traditional bamboo-hooped wooden barrels and large wooden tanks for the questionnaire survey in this study, both are included in the results on number of items in possession.

As outlined above, no one knows exactly how many wooden barrels are currently used for soy sauce

production, how rapidly scrapping of the barrels will proceed, or whether new and recycled barrels can be introduced fast enough to keep pace with the number of discarded barrels. Understanding the trends in wooden barrels through information from related businesses will allow us to keep an ongoing record of the disappearance and revival of Japanese wooden barrel brewing culture.

This research constitutes one part of our food culture research aimed at creating a record connecting the past to the present and onto the future. We hope that by sharing this record with people concurrently engaged in soy sauce brewing and the fermentation and brewing industries, we can contribute to the protection and succession of the wooden barrel brewing culture – one aspect of Japanese food culture.

SURVEY METHOD

In August 2019, we requested the participation of soy sauce brewers nationwide in a questionnaire survey through the National Federation of Soy Sauce Industry Cooperatives, and responses were collected by fax or mail. In March 2020 and again in March 2021, we reconfirmed the number of wooden barrels in possession with brewers who answered they owned them as well as with brewers who did not respond in 2019, and tabulated the results.

The questions investigated the kind of fermented seasonings produced (soy sauce, miso, vinegar, mirin, sake, other (multiple choice); the number of wooden barrels owned, separated by usage status (used for soy sauce production, currently unused but can be used, used for other purposes such as exhibits) and by capacity (number of koku or kiloliters); and thoughts on future increases or decreases to the number of wooden barrels (maintain status quo for the time being, increase, decrease, desire to newly obtain), and in the event of a present desire to change current barrel numbers, the preferred specific means for doing so.

RESULTS AND DISCUSSION

(1) Number of soy sauce brewers who own wooden barrels and total number of wooden barrels in possession

A total of 459 soy sauce brewers answered the questionnaire, of which 281 owned wooden barrels (including two brewers not belonging to any cooperative). This represents about 25% of the total 1,141 soy sauce brewers reported to exist in 2019¹⁶⁾.

The total number of wooden barrels owned by 281 brewers nationwide was 6,731, of which 4,765 are used for soy sauce production (hereinafter referred to as “in use”), 1,261 barrels are currently unused but can be used (hereinafter, “unused”), and 705 barrels are unusable for soy sauce production even after repairs due to leaks or long-term disuse, or whose condition is unknown (hereinafter, “unusable”). The survey revealed seven prefectures without a single wooden barrel-owning brewery: Kanagawa, Yamanashi, Osaka, Tottori, Saga, Okinawa, Kagoshima.

Figure 1 shows the number of wooden barrels by usage status across the eight regions of Japan. In Shikoku, 21 brewers held a total of 1,305 barrels, with a notably high ratio of those barrels “in use”, most of them in Shodoshima. Both the number of brewers owning wooden barrels and the number of barrels “in use” by region as shown in Fig. 1 have already been reported in the *Ajinomoto Foundation for Food Culture Center Research Results Summary Report*¹⁷⁾.

Figure 2 shows a breakdown of the total barrel numbers by usage status and capacity. Of the 4,765

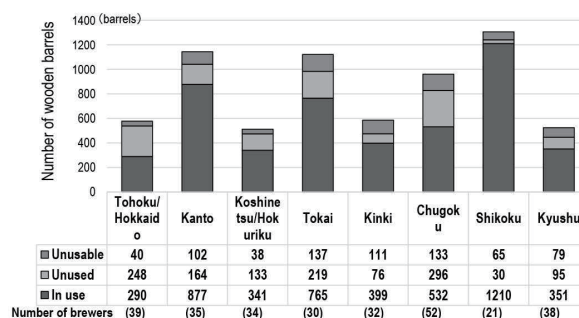


Fig. 1 Total number of wooden barrels owned by soy sauce brewers (by region and usage status)

barrels “in use” nationwide, 2,064 barrels had a capacity of around 30 koku (5.4 kL) and 1,269 were around 20 koku (3.6 kL), together accounting for 70% of the total. These also accounted for about 60% of “unused” and “unusable” barrels, showing the 20 to 30-koku capacity as the most common size among existing wooden barrels for soy sauce production.

(2) Number and regional characteristics of wooden barrels in use for soy sauce production

Figure 3 shows the number of wooden barrels in use by capacity for the eleven prefectures with the highest ownership of wooden barrels.

First, Kagawa Prefecture has by far the most with a total of 1,113 wooden barrels in use across eight breweries. There are only minor differences between the second-ranked Aichi Prefecture (13 breweries, a total of 387 barrels) and the ones below it. Looking at larger regions following the standalone Kagawa Prefecture, there are a total of 701 barrels in three

prefectures of the Tokai region (Aichi, Mie, Gifu); 811 in the three Kanto prefectures (Ibaraki, Chiba, Saitama); and Fukuoka, Shimane and Hiroshima prefectures, which are geographically relatively close in western Japan, follow with a total of 669 barrels.

By capacity, Kagawa Prefecture has 1,040 barrels around 30 koku (5.4 kL) – representing almost all of the total 1,113 barrels in use in the prefecture.

Looking at the Tokai region, in Aichi Prefecture, 221 of the 387 total barrels in use are around 30-koku capacity, and 130 barrels are around 40-60 koku (7.2 to 10.8 kL). In ninth-place Gifu Prefecture (4 breweries, 131 barrels in total), there are 65 barrels around 30 koku, and another 40 barrels in total around 40, 50 and 70 koku. Mie Prefecture in eighth place (10 breweries, 183 barrels in total) has 80 barrels around 30 koku and 28 barrels around 40 to 60 koku. Although small capacity barrels are also used, in general, it can be said that there is high usage of large barrels of more than 30 koku in the Tokai region.

Common among third-place Fukuoka Prefecture (18 breweries with a total of 299), sixth-place Shimane Prefecture (16 breweries with a total of 256), and eleventh-place Hiroshima Prefecture (11 breweries with a total of 114) is the prominence of relatively

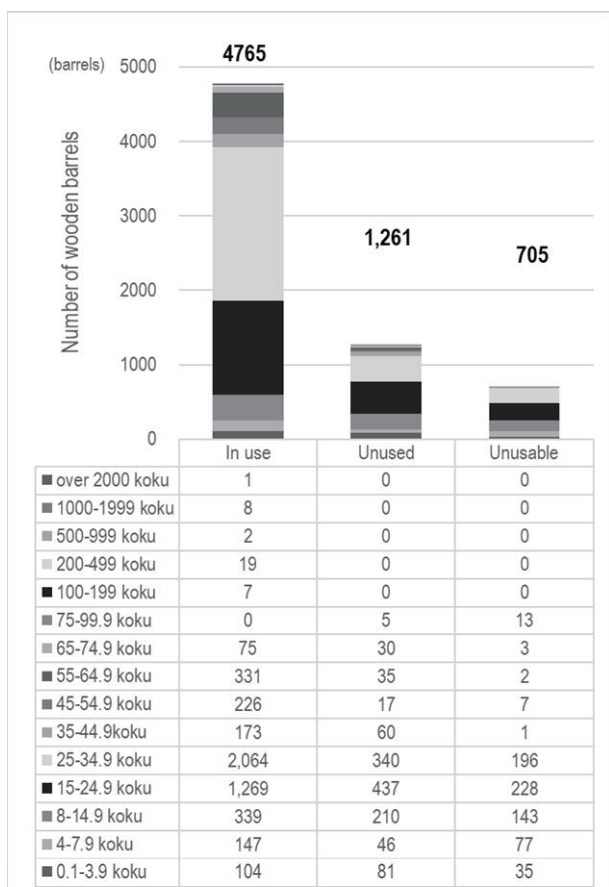


Fig. 2 Total number of wooden barrels owned by soy sauce brewers (by usage status and capacity)

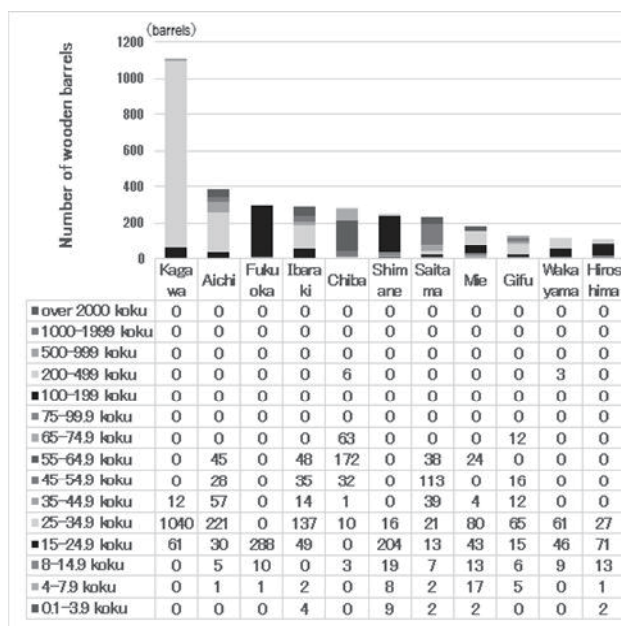


Fig. 3 Number of wooden barrels in use by capacity in prefectures with the highest ownership

smaller barrels around 20-koku capacity (3.6 kL), though there are differences in the breakdown. In Fukuoka Prefecture, one brewery alone owns 200 of the prefectural total of 288 barrels around 20 koku capacity, and not a single barrel over 30 koku is in use in the prefecture. In Shimane Prefecture, of a total of 204 barrels around 20 koku, the brewery with the most owns 79 barrels, and in many cases individual breweries own wooden barrels in a range of sizes, from small ones to large ones around 30 koku. On the other hand, in Hiroshima Prefecture, just two breweries own a combined 87 of 114 barrels, which breaks down as 59 of the 71 barrels around 20 koku and all 27 of the approximately 30-koku barrels.

Moving to the Kanto region, in Ibaraki Prefecture (11 breweries, 289 barrels in total), 137 barrels are around 30 koku and 97 barrels are around 40-60 koku. In Chiba Prefecture (8 breweries, 287 barrels in total), most of the barrels are in the 50-70 koku range, with a very high proportion around 60 koku. In Saitama Prefecture (6 breweries, 235 in total), most barrels are between 40 and 60 koku, with the highest number around 50 koku. This shows that the wooden barrels currently in use in the Kanto region are typically larger than the nationwide average.

As shown in Fig. 2, there is a total of 805 large-capacity wooden barrels between 35 and 75 koku across Japan, with 753 or 93.5% of those held by the top six prefectures – Aichi, Mie, Gifu, Ibaraki, Chiba, Saitama – all of which are located in the Tokai and Kanto regions. Of all the barrels in use around 30 koku capacity, Kagawa, Wakayama and the above six prefectures own 1,635 barrels of the total 2,064 nationwide, which accounts for 79.2%. In these prefectures, clearly the use of large wooden barrels has evolved and endures today.

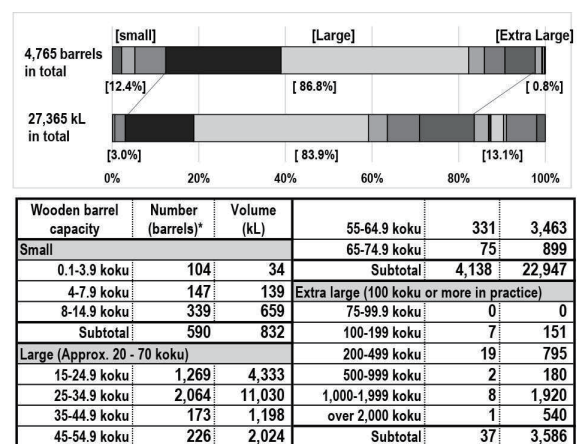
There are several possible factors for this. First, the existence of a supply-demand relationship for delivering high-volume, homogeneous products to market for the mass consumption areas of Edo and Osaka from surrounding prefectures, as evidenced in the statement, “The basic shape of the 30 koku barrels we see today was established in Nada before the

Kansei era (1789-1801)”⁷⁾. Second, there is limited stirring work in miso and tamari soy sauce brewing, which are the mainstream in the Tokai region, thus the large barrels presented few disadvantages. There may be other factors including the distribution of raw materials such as Yoshino cedar and local timber, and the spread of large barrel-making technology, but further investigation is needed in the future.

(3) Relationship between total capacity and the number of wooden barrels in use

Next, the total capacity of wooden barrels used for soy sauce production nationwide was calculated by multiplying the capacity of wooden barrels and the number of wooden barrels in use found in the questionnaire responses. The top half of Figure 4 shows the association between the total number and capacity of wooden barrels in use nationwide separated by barrel capacity. The bottom half of the figure contains the number of wooden barrels in use for soy sauce production owned by the 281 brewers that responded to the survey with subtotals of small, large and extra-large capacity barrels adding up to a total of 4,765 barrels nationwide with total capacity of 27,365 kL (152,026 koku).

Figure 5 shows the total capacity of wooden barrels in use held in each of the eleven prefectures with the highest levels of ownership and this is broken down



*These numbers are reproduced from Fig. 2

Fig. 4 Association between the total number and capacity of wooden barrels in use

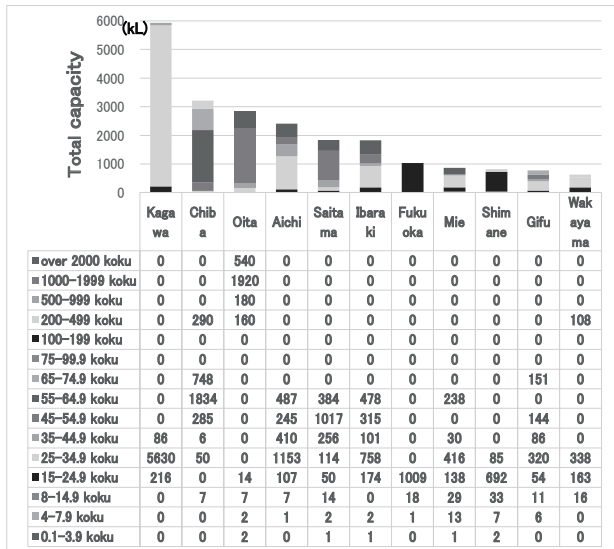


Fig. 5 Total capacity of wooden barrels in use in the eleven prefectures with the highest levels of ownership

by barrel capacity.

We interviewed two breweries in Shodoshima and Saitama Prefecture regarding soy sauce yields as a ratio of raw materials and salt water in the case of wooden barrel preparation. From this we calculated the amount of soy sauce produced as a ratio of the capacity of the wooden barrels, obtaining a rough number of 50%. Of course, we cannot simply calculate the amount of soy sauce produced based on the total capacity of a wooden barrel given the mash can be fermented and aged in a barrel from as little as one year up to three years, however, this would suggest that a little less than 14,000 kL of wooden barrel-prepared soy sauce is produced annually.

As shown in Fig. 4, the total number of extra-large wooden barrels with capacity of 100 koku (18 kL) or more is 37, or just 0.8% of all barrels in use, but the total capacity amounts to 3,586 kL, changing the ratio significantly to 13.1%. In the future, if more wooden tanks are introduced while traditional bamboo-hooped wooden barrels continue their natural decline, we will see changes in the proportion of wooden barrel-prepared soy sauce distributed in the market accounted for by each type of wooden vessel.

From Fig. 5, Kagawa Prefecture ranks first in terms of total capacity, but the difference between Chiba, Aichi, Saitama, and Ibaraki prefectures, which have

many large wooden barrels, is not as remarkable as the difference in the number of barrels. It should be noted that Oita Prefecture, ranked 29th in terms of the number of wooden barrels (31 in total), is in third place in the capacity rankings because extra-large wooden vessels ranging from 200 to 2000 koku (36 to 360 kL) or more are typically used.

The largest capacity bamboo-hooped cedar barrel in Japan can be found in Aichi Prefecture and is used for producing miso¹⁸⁾. However, in soy sauce brewing, while we were able to confirm the use of barrels around 70 koku in capacity (63 in Chiba Prefecture, 12 in Gifu Prefecture) in this survey, there were no reports of barrels in the 75-100 koku range, thus it is thought that preparation of volumes greater than 100 koku is instead undertaken in wooden tanks.

The estimated annual production of soy sauce prepared in wooden barrels calculated in result (3) is less than 14,000kL, or 1.88% of the total soy sauce shipment volume of 744,263 kL in 2019¹⁶⁾. If the introduction of extra-large wooden tanks continues, even if the total number of wooden barrels decreases, it is possible that the ratio of soy sauce prepared in wooden vessels of some variety to total shipment volumes will be maintained or even increased.

(4) Soy sauce brewers' future intentions for wooden barrel ownership

Figure 6 shows the results of 444 valid responses out of 459 responses regarding the desire to increase or decrease the number of wooden barrels in the future.

Of the 444 breweries, 75% expressed an intention to maintain the status quo of either the current number of holdings (177 breweries) or no barrels at all (157 breweries). A total of 55 breweries (12.4%) wanted to increase the number of wooden barrels, of which eleven breweries did not currently own any but wanted to obtain some and 44 breweries wanted to increase the number owned. A further 55 companies hoped to reduce the number of barrels owned.

Of the 44 breweries that wanted to increase existing numbers, as many as 29 breweries wanted

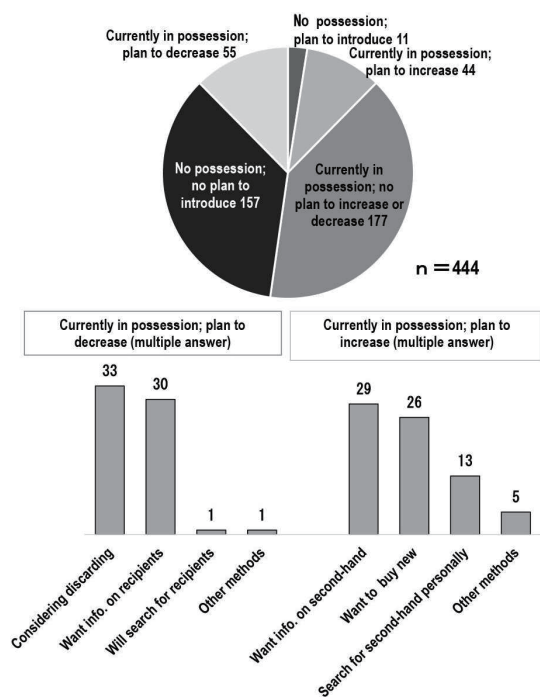


Figure 6 Intention to increase or decrease the number of wooden barrels in the future.

information on where to obtain second-hand barrels, 26 breweries wanted to buy new barrels, and 13 breweries wanted to search for second-hand barrels themselves. In addition, of the 55 breweries wishing to decrease the number of barrels in possession, about half were thinking of discarding them, and the remainder wanted information on possible recipients as they wished to give them away.

Table 1 is a summary of the free-form comments obtained from 86 breweries, classified according to the intention to increase or decrease the number of wooden barrels owned and excluding details on current numbers of wooden barrels and capacity.

Many comments from the 24 breweries that do not currently own wooden barrels and have no desire to introduce them in the future detailed how they disposed of their wooden barrels for reasons such as difficult hygiene management and quality control, labor intensiveness, and the absence of wooden barrel craftsmen, making repairs impossible. There was also expression of a wish that wooden-barrel prepared soy sauce not be considered the genuine article. From some of the 16 breweries that currently own barrels but wish to reduce numbers, we received comments

Table 1. Results of Survey on Intentions to Increase / Decrease Number of Wooden Barrels (free-form comments classified by main intention)

Free-form comments (86 companies in total)	Reason summary (number of cases)
No possession; no plan to introduce (24 breweries)	Difficult hygiene management (6), used before but disposed of (5), difficult to control quality (4), due to absence of wooden barrel craftsman (3), due to HACCP compliance (2), labor required (2), never used wooden barrels (2), don't want wooden barrel preparation to be considered the only genuine article, few merits to new introduction, valuable for exhibit purposes, difficult to repair, difficult to purchase new barrels, a business partner told me that I should have kept wooden barrels
No possession; plan to introduce in the future (2 breweries)	I think they have value in terms of differentiation, but the hurdles are high for <i>kiage</i> * manufacturers. Do not think traditional natural brewing means wooden barrel brewing, and our main brewing is with FRP, but want to try wooden barrel brewing in small quantities for a limited product line. *kiage is unpasteurized soy sauce
Currently in possession; plan to reduce (16 breweries)	Barrels abandoned / condition unknown (4), difficult hygiene management (2), unusable due to liquid leakage (2), plan to close the business (2), want to keep a few (2), discard wooden barrels, we have usable wooden tub, follow guidance of health center, labor is required, difficult to maintain due to absence of barrel craftsmen, want to change to FRP, value in holding for brewery tours, good for exhibition
Currently in possession; plan to increase (16 breweries)	I want to repair / repair information (4), I want to introduce new barrels (2), I want to consider introducing new ones in the future, I want to replace the barrels, I want information on repair companies, I want information on wooden barrel craftsman, would be nice to have craftsmen based in the Kanto region, new barrel production and maintenance of repair techniques both indispensable, I think the value of wooden barrels will continue to rise, I use them carefully, there are merits to preparing in wooden barrels, we should retain wooden barrel culture, will manufacture new barrels in-house

including that they left barrels unused because of the difficulty in hygiene management, that they plan to close the business, or that they hope to reduce the number but want to keep a few for exhibition purposes.

Many comments were also made about the value of wooden barrels from two companies that do not currently own but are considering introducing them and the 16 breweries who want to increase numbers. Requests for information on repairing wooden barrels in use and on repair companies were raised by these breweries as well as 28 breweries that want to maintain current numbers, and the need to increase the number of wooden barrel craftsmen to make new barrels was also highlighted.

In addition, some breweries commented on a desire to use barrels in combination with FRP or to convert to FRP, and others expressed a wish to better understand the meaning and clear merits of brewing in wooden barrels compared to vessels made of other materials like FRP. It became clear that even among

brewers using wooden barrels, some have not yet found a clear answer about their merits.

CONCLUSION

1) Based on the responses from 281 soy sauce breweries who own wooden barrels as of 2020, there are a total of 6,731 wooden barrels for soy sauce production nationwide, of which 4,765 (70.8%) are in use, 1,261 (18.7%) are currently unused, and 705 (10.5%) are unusable, including items that have been used for other purposes such as exhibits or have been left idle in unknown condition.

2) Soy sauce brewers using wooden barrels are scattered all over the country, from Hokkaido in the north to Miyazaki in the south. We found notable accumulations of barrels in Shodoshima, the Kanto area (Ibaraki / Chiba / Saitama prefectures), Tokai (Aichi / Mie / Gifu prefectures), and western Japan from Kitakyushu to the Chugoku region (covering Fukuoka / Shimane / Hiroshima prefectures).

3) In terms of capacity of the wooden barrels in use, most are around 30 koku (2,064 barrels), followed by barrels with capacity of approximately 20 koku (1,269), 10 koku (339), 60 koku (331), 50 koku (226), and 40 koku (173). Capacity figures revealed regional characteristics with mainly 30 koku barrels in Shodoshima, larger 50-60 koku barrels in Kanto, and 20 koku barrels in Fukuoka, Shimane and Hiroshima prefectures.

4) Assuming that the ratio of soy sauce yield to capacity of the wooden barrel is 50%, and given the total number of wooden barrels is 4,765 with a total capacity of 152,026 koku (27,365kL), we estimated that a little less than 14,000 kL of soy sauce can be brewed in wooden barrels annually. This amounts to 1.88% of total soy sauce shipment volumes in 2019.

5) The number of extra-large wooden vessels with capacity of 100 koku or more was just 0.8% of the total number in use, but they accounted for 13.1% of the total capacity. The further introduction of extra-large wooden barrels (wooden tanks) of even greater magnitude is expected to significantly change the balance between the volume of soy sauce on the

market prepared in wooden barrels and the number of wooden barrels.

6) Regarding intentions to increase or decrease the number of wooden barrels owned, about 75% of the 444 breweries that responded planned to remain at zero or maintain the current number, 12.4% wanted to increase numbers, and 12.4% wanted to decrease numbers. In addition, many of the wooden barrel owners expressed anxiety about repairs and wanted information on the transfer of barrels, and there was also a request for clearer understanding around the merits and differences of wooden barrel preparation.

RESEARCH LIMITATIONS AND FUTURE ISSUES

In this study, we were able to estimate the potential production volumes of soy sauce prepared in wooden barrels by ascertaining the number of wooden barrels for soy sauce production of each size through a national survey of 2020 figures.

The following three points can be raised as future tasks. First, because we cannot be certain that all soy sauce brewers owning barrels for soy sauce production responded to this survey, we must continue to collect information and connect it to the next survey. Next, regarding the areas where information sharing within the industry was desired, such as repairs, purchase of new barrels, and transfer of second-hand recycled barrels, it is hoped that the reporting of these research results to various organizations will prompt consideration of possible solutions. Finally, while we showed that there are regional variations in the capacity of wooden barrels, this paper only demonstrates number and capacity differences and was not able to explore further from historical and food culture perspectives.

This research represents a starting point for examining how the soy sauce wooden barrel culture may be passed on to the future. Going forward, we expect to conduct similar surveys on an ongoing basis every three to five years, specifically examining the number of natural reductions due to aging, the number of disposals due to business closures, the

capacity and availability of second-hand barrels, and the number and capacity of new barrels introduced. Doing so will make it possible to predict shifts in the production of soy sauce prepared in wooden barrels and the state of wooden barrel culture at fermentation and brewing sites in Japan.

Currently, “wooden barrel” (kioko) is the general nomenclature to describe all wooden vessels, and soy sauce prepared in both traditional bamboo-hooped wooden barrels and large wooden tanks is all described as “wooden barrel-prepared soy sauce”. Some Japanese soy sauce prepared in wooden barrels is being called “Craft Shoyu” and is attracting attention in the United States and Europe. One brewer shipping such soy sauce celebrates its preparation in “traditional wooden barrels”, referring to wooden barrels with bamboo hoops. In the future, we hope to focus on trends in classifications of these names based on recommendations within the industry or requests from consumers.

During an interview, we heard from a miso and soy sauce brewer in Mie Prefecture that the scene of a brewery lined with wooden barrels is the very manifestation of brewing culture at soy sauce and miso breweries. In Mie Prefecture, a strong wooden barrel culture endures at many producers of tamari soy sauce. When we visited several breweries, we saw that some had introduced wooden tanks also made of cedar but fastened with a metal band, the same size as traditional bamboo-hooped wooden barrels. And a Hatcho Miso brewer in Aichi Prefecture has begun a trial introduction of wooden tanks with the same capacity and shape as conventional wooden barrels.

While there is a movement to make new barrels with bamboo hoops in the traditional style, with the number of craftsmen making traditional wooden barrels on the decline, we are also seeing the introduction of new types of wooden vessels like wooden tanks. What kind of wooden vessels will complete the landscape of the soy sauce brewery 100 years from now? We hope that this research report on the situation in 2020 will serve as a small cornerstone for passing on the Japanese wooden barrel culture.

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