

Chapter 4



Soy Sauce, '*Shoyu*', is a World-Famous
Seasoning of *Umami*

Unlike Japanese *sake* or *miso*, *shoyu* (醤油) labeled “Soy Sauce” has become one of the most popular liquid seasonings and is sold at a lot of stores in the world. I think it is because rich *umami* elements are contained in soy sauce and people of almost all the races in the world feel it delicious. Soy sauce is the main seasoning in cooking *washoku*, or traditional Japanese cuisine.

4.1 *Washoku*, Japanese home cooking, is the UNESCO intangible cultural heritage

You may have heard of ‘*washoku*’ recently since *washoku*, traditional Japanese cuisine, has been widely lauded and recognized around the world. In December 2013, it was recognized as the UNESCO Intangible Cultural Heritage.

Ms. Takako Kotake of the editor-in-chief of COOKPAD, Japan’s largest recipe site, introduces *washoku* as follows; “Japanese home cooking, *washoku*, is indeed unique in that it is centered on the happiness and health of the family. It nourishes families with seasonal ingredients, brings smiles to their faces, and is prepared easily on an everyday basis”. You can find many popular recipes of *washoku* on website including COOKPAD, which may inspire you to the daily rhythm of cooking. She continues, “Most are classic dishes passed on from grandparents to their daughters and to their granddaughters, and the recipes have withstood the test of time. Therefore, *washoku* is one of the important Japanese cultures. *Washoku* is not difficult to prepare”. She encourages further, “The recipes you can get on websites may not require special ingredients or tools, and even if you are unable to obtain some of the ingredients, you can substitute with what’s at hand. Whatever the result, you should try it. It is your turn to cook Japanese cuisine. There is no right or wrong answer. I hope you will have a go at *washoku* cooking in your own kitchen”.

4.2 The fifth taste ‘*Umami*’ was born of *Washoku*, traditional Japanese cuisine

The essence of *umami* components can be said to be the taste of *washoku*, for which people have been making use of broths of *kombu*, a kind of kelp (*Laminaria japonica*) (Fig. 4.1, A and B) and dried bonito flakes, *katsuo-bushi* (Fig. 4.2, C and D). This *umami* taste is made out of *umami* components, like monosodium glutamate in *kombu*, one of amino acids, or nucleic acids in dried bonito flakes like disodium inosinic acid or disodium guanylic acid. These *umami* taste components are extracted by boiled *kombu* and *katsuo-bushi* and they are used for traditional *washoku* cuisine.

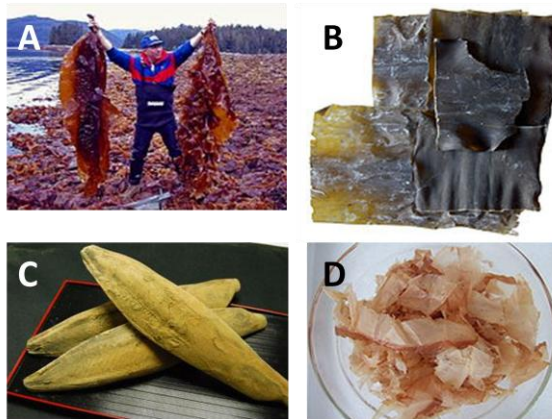


Fig. 4.1 *Konbu (Laminaria japonica) and dried bonito, katsuo-bushi.*

A, Harvested *konbu* in Hokkaido, Japan; B, dried *konbu*; C, dried bonito; D, *katsuo-bushi*, sliced bonito. (Pictures A and B quoted from ja. Wikipedia.org; C and D quoted from commercial home pages, Japan.)

Dr. Hans Henning, a psychologist of Germany, once insisted that human beings can feel the four basic tastes, sweet, sour, bitter and salty. Only the four tastes were known in Western countries. Afterward, ‘*umami*’ taste was recognized as a basic taste by the skill of sensory analysis and neurophysiology,

and Japanese word 'umami' came to be used in English. It is interesting that the fifth taste umami, which was a natural taste for Japanese, was not known in Europe or America.

4.3 Industrial production of *Umami* was born by Japanese fermentation skill

These days, a lot of people in the world use commercialized umami instead of extracts of '*kombu*' and '*katsuo-bushi*', about which I will explain in later chapters. In former times, several kinds of amino acids including glutamic acid were obtained by hydrolytic cleavage of wheat gluten (protein).

Dr. Shukuro Kinoshita's research group of Kyowa Hakko Co. (Machida, Japan) invented microbial mass production of glutamic acid. Because organisms control production of biochemical compounds, even amino acids are formed at appropriate amounts in the cells. Thus, if excess amounts of compounds are formed in the cells, the organism stops their formation. Scientifically we refer to this mechanism as 'feedback-repression or -inhibition'. Dr. Kinoshita *et al.* broke this metabolic control in a bacterium by mutagenesis, and the resultant mutant bacterium produced a large amount of glutamic acid in the cell. By using this technique many other amino acids, such as lysine, methionine, tryptophan, *etc.* have been produced by mutated bacteria, too and they were commercialized. Most people know it as the commercial name 'Ajinomoto', which comes from the name of a food company in Japan.

Similarly, another umami compounds, inosinic acid and guanylic acid have been produced by enzymatic technology and fermentation technology with mutated bacteria. The former technology was invented by Dr. Akira Kuninaka of a soy sauce company in Chiba, Japan.

4.4 How and where do we feel tastes and smells?

How do we recognize these basic tastes as sweet, sour, salty, bitter or delicious? The tongue and palate are covered with about one hundred tissues called taste bud. Taste cells on these taste buds receive the chemical substances of sweetness, bitterness and umami and send them to brains by the separated pattern of signals. On the other hand, the tastes of sourness or saltiness are conveyed to the brain as an electric signals made by opening ion-channels of hydrogen ions or sodium ions on the surface of the taste bud cells. It seems that the brain recognizes the difference of electric signal patterns and detects the difference of tastes.

Similarly, smell of foods is also important as an appetizer and it can play a role in understanding the mechanism in molecular level. The olfactory receptors, which are found at least 347 at olfactory cilia in a human nose, receive smell substances and then transfer this information to brain through biochemical transduction including adenylyclase, calcium-sodium channel and calcium dependent chloride channel. This molecular mechanism was clarified by Drs. Richard Axel and Linda B. Buck, and they received the Nobel prizes by this research. Amazingly, scientists think that we recognize about 400,000 volatile chemical compounds by combination of about one thousands olfactory receptors.

4.5 Why do people of every race feel soy sauce delicious?

The reason why umami taste of soy sauce is loved by people of every race in the world, whether they are carnivorous or herbivorous, may be that we, human beings, take sugars which are made from starch, amino acids which are made

from protein, fatty acids which are made from lipids, and nucleic acids which are made from genetic DNA or RNA when we digest each of them.

At the same time, there is another reason why we feel umami delicious, that is, umami is a result from the interaction between umami components, nucleus acids and amino acids. In addition to umami, other four basic tastes have a synergistic effect, too. For instance, when we put salt into sugar, sweetness of sugar is enhanced, and when we put sugar into bitter substances, bitterness is controlled. The example of the former is to sprinkle salt on a piece of a cut watermelon and the example of the latter is chocolate. Soy sauce will be a good example of the synergistic effect. Smelling also shows synergistic and masking effects as you know, and I feel soy sauce giving good smell.

By the way, the tastes, such as rough, spicy, acrid and metallic, are caused from complex feelings, so they are not included among five basic tastes.

4.6 Japanese soy sauce was born from *Miso*

The view that soy sauce, *shoyu* was invented out of *tamari* of *Kinzanji-miso* by a Buddhist bishop at *Yura* in *Kishu* (Wakayama) area in Kamakura era (1192~1333) seems to be believable. The book, '*Qimin Yaoshu*' about which I introduced in Chapter 2, shows us how to make '*hishio*'. It says that the contents of '*hishio*' are mostly like salted beef guts, so it seems different from the origin of Japanese *shoyu*. Although many other sauces that are produced in China and Southeast Asia are made from fish or grain and they resemble *shoyu* visually, these sauces are not categorized as soy sauce.

4.7 Traditional and modern methods of soy sauce production

Japanese traditional soy sauce is produced in wooden tanks by static fermentation for 1 to 2 years (Fig. 4.2). Moistened soybeans are cooked at high pressure and high temperature, while wheat is roasted and ground. Then almost the same amounts, by weight, of soybeans and wheat are mixed with a small amount of seed *koji* mold. The mash, which contains *koji*, salt (15~17%) and water, is called *moromi*, and is fermented in large enamel or stainless tanks for 6 to 8 months at room temperature or higher. Several kinds of *koji* mold are used for fermentation, and one of them is *Aspergillus oryzae*, which is also used for brewing Japanese *sake*, and the other one is *Aspergillus sojae*, which is tolerant against salt. *Sojae* was named so, because the mold was separated from soy sauce. Fermentation is assisted by the propagation of lactic acid bacteria and yeasts which are also tolerant against salt. Finally, the aged *moromi* is pressed and the liquid exudate is pasteurized to yield soy sauce.



Fig. 4.2 Traditional soy sauce brewing.

Left, fermentation room at Kanro-Shoyu Brewing Co., Yanai, Yamaguchi; right, ingredients used for soy sauce production at Higashimaru Shoyu Co., Tatsuno, Hyogo, Japan.

Japanese *shoyu* is classified into *usukuchi* (weak taste, Fig. 4.3), *koikuchi* (thick flavor, Fig. 4.3), *tamari* (thicker flavor), *saisikomi* (twice-brewed) or *shiro* (white) according to the ratios of raw materials used (Fig. 4.2), the microorganisms employed and the conditions of fermentation. The taste of *shoyu* is full of local colors and the dishes in each area of Japan have its own characteristics by using *shoyu* of the area.

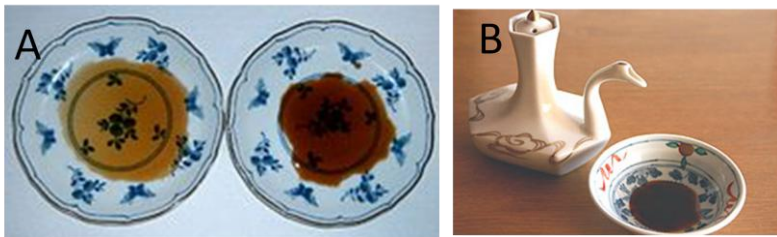


Fig. 4.3 Soy sauce, *Shoyu*.

A. Left; *usukuchi shoyu*, light soy sauce; right, *koikuchi shoyu*, heavy soy sauce.
B. ceramic *shoyu* pot.

Nowadays, a great deal of good soy sauce, rice vinegar and Japanese *sake* are produced in modern computer-controlled systems, from the cooking of raw materials to bottling (Fig. 3.6; Fig. 4.4.).



Fig. 4.4 Aging of soy sauce production in modern factory.

4.8 Soy sauce is also a seasoning which is good for health

Soy sauce promotes the secretion of gastric juice in humans. It contains certain bioactive components in addition to its taste components, such as amino acids, polyols and aromatic compounds resulted from its ingredients and complicated fermentation with many kinds of microorganisms^{*1}. Therefore, soy sauce has many merits as follows;

1. stimulates the secretion of acidic juice in the stomach.
2. anti-bacterial effect by bioactive compounds together with salt.
3. anti-oxidant effect by amino acids or various aromatic compounds like polyols.
4. anti-carcinogenic effect by flavor elements.
5. the effect of decreasing blood pressure by inhibition of angiotensin I-converting enzyme.
6. excellent anti-allergic potential.

During fermentation and subsequent aging of soy sauce, the proteins in soybeans and wheat are completely digested to short peptides and amino acids by microbial proteolytic enzymes, and none of the allergens present in the raw materials can be seen in soy sauce. The oral administration of polysaccharides originated from the cell walls of soybeans was shown to be effective as a treatment for patients with allergic rhinitis. Thus, soy sauce is not only a traditional seasoning but also a functional seasoning^{*2}.

4.9 Please do not drink soy sauce even if it is good for health

I should advise you here. Even if soy sauce is good for health, you should not take a lot of soy sauce because it contains pretty much salt. If you take much soy sauce, concentration of sodium-ion increases and ion-balance of cells in your body gets lost, and you will be affected by a kind of physical condition similar to heatstroke. The daily consumption of soy sauce in Japan has been estimated to be close to 30 ml per person. Thus, on average, the Japanese consume approximately 4.5 g of NaCl per day per person as soy sauce.

One of the ways that we can take less salt is to make use of the interaction of taste I touched in this Chapter. We can lessen salt by adding umami to salt. However, if we lessen salt, sterilizing power and preservative effect get weak. So we have to think out another method of making up for it. I think that soy sauce mixed with bitter orange juice like citron is a wonderful invention from the point of the interaction of taste. One of the commercial names of its invention is 'Ajipon' or 'Ponzu'. Since this product contains salt (from *shoyu*) and acid (from citron or vinegar), infected microorganisms are hard to grow at room temperature.

4.10 We can buy soy sauce at many stores all over the world

There remains a record that Japanese *shoyu* started to be exported in Edo-era (1603~1868). It says that *shoyu* was carried by Dutch or Chinese ships to Chinese mainland, Southeast Asia, India, Sri Lanka and Holland and it was highly prized.



Fig. 4.5 Export volume of soy sauce.

(Report from Shoyu Information Center, Japan Shoyu Association. 2012.)

Until recently, the amount of exports of soy sauce had increased twice of rice vinegar and Japanese *sake*, but it has reached its ceiling (Fig. 4.5). It is because the amount of local production in overseas increased and it is ten times the amount of exports. Thus, people all over the world came to get soy sauce at any store in the world. I, myself, found soy sauce in a supermarket located in the countryside in Switzerland, Italy and Austria when I went trekking around Alps area.

By the way, as you know, genetically modified soybeans are used in most cases, when processed foods are made out of soybeans, like soy sauce in the USA (Fig. 4.6). However, you don't have to fear them. I think it is safe. I will explain about genetically modified foods in the next Chapter.



Fig. 4.6 Visitors at a soy sauce factory in Sacramento, CA, USA.

4.11 Summary

Japanese traditional soy sauce, 'shoyu', is produced from soybeans, wheat, salt and water with *koji* by static fermentation for 1 to 2 years. In this fermentation salt tolerant yeast and lactic acid bacteria also work crucially. Soy sauce makes us feel a large amount of umami. The umami taste is made out of umami components, monosodium glutamate in *kombu*, or nucleic acids in dried bonito flakes (*katsuo-bushi*), disodium-inosinic or -guanylic acids. *Shoyu*, which contains these components extracted from boiled *kombu* and *katsuo-bushi*, are used for traditional *washoku* cuisine. It promotes the secretion of gastric juice in humans. It contains certain bioactive components in addition to its taste components, such as amino acids, polyols and aromatic compounds made from its ingredients by mixed fermentation with many kinds of microorganisms. Thus, soy sauce is not only a traditional seasoning but also a functional seasoning.

That's why Japanese Food is Loved All Over the World
- The Source of the Health and Longevity

*¹ Kataoka, S., Functional effects of Japanese style fermented soy sauce (shoyu) and its components. *Journal of Bioscience and Bioengineering*, 100:227-234 (2005).

*² Kobayashi, M., immunological functions of soy sauce: Hypoallergenicity and antiallergic activity of soy sauce. *Journal of Bioscience and Bioengineering*, 100:144-151 (2005).