Review article

Korean traditional fermented soybean products: *Jang*

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A B S T R A C T

Soybeans are produced in large amounts around the world. In Asian countries, soybeans have been used mostly as a source of food, and in Western countries, they have been used as animal feed and in non-food products. However, since scientific evidence of the dietary benefits of soybeans has been published, the use of soybeans as a food ingredient has increased. In Asia, soybeans have been used in various ways on their own and also combined with fermented products to be used as seasonings or side dishes. According to some sources, the use of soybeans in Korea dates back to B.C. Currently, more research is being conducted on soybeans, and the benefits of fermented soybean products are coming to light.

Fermented products are going beyond the boundaries of their use as mere side dishes, and are seeing significant increases in their use as a functional food. Kanjang (fermented soy sauce), Doenjang (fermented soybean paste), and Gochujang (fermented red pepper paste) are the most well-known fermented products in Korea. These products occupy an important place in people's daily lives as seasonings and are used in many side dishes. It has been proven through clinical studies that these products have many health benefits, such as their ability to fight cancer and diabetes, and to prevent obesity and constipation.

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1. Introduction

In East Asia or Southeast Asia, soybeans have been recognized as a very important food source that has affected dietary life in many ways [1,2]. Starting in the twentieth century, Western countries, including the United States, acknowledged soybeans as feed and as a source of vegetable fat and oil. But since protein and the unique psychological functions of soybeans have been identified, their importance from a dietary perspective is also being emphasized.

Historically, Korea has a deep relationship with the soybean [3], and its usage dates back to 4,000 years ago. The Korean people's preference for soybeans is connected to the fact that the birth place of the soybean is Manchuria [1], and that it has acted as a great source of protein for Koreans since that time.

In Korea, soybeans are boiled and made into fermented products, or used as an ingredient for rice with beans, Injeolmi (rice cake crumbs), soy milk, and soybean oil [4]. Fermented soybean products in particular, have become an essential part of the Korean diet, used as seasoning and found in side dishes and soups that are consumed daily. An increased demand for these sauces in Korea in recent times has given rise to greater commercial production and control over development processes, including the fermentation process. The traditional fermented products have various flavors because different kinds of microorganisms are involved. However, in commercial products, only monomicrobial interception takes place, so the taste is sweet and rather simple. For this reason, there are soy sauce products that cater to the traditional customer base as well products for those looking for more variety to their sauces. This article will analyze the fermentation process used in the creation of a variety of sauces in Korea, including microbial fermentation.

2. Korean fermented soybean products: *Jang*

In the plant, the soybeans contain the most protein, and therefore, different methods of use have evolved. Soybeans can be used in their natural state, or by decomposing the protein into fusible substance, the most widely used method. This means the soybeans can be used as a seasoning or as a nutrient source with added amino acid and peptide.

For more than thousand years, people in Asian countries have let the microorganism in the boiled soybeans increase. They used the essential taste components earned from the breaking down of protein through the enzyme reaction. Some of the soybeans are made into paste and used in soup to be eaten with rice. Ethnic

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groups which consume fermented soybeans are called “Fermented Soy Jang Culture,” where Jang in Korean means soy fermented sauce or paste [1, see the previous paper by Kwon et al in this issue], and East Asia is categorized in this group. Most of the people living in these areas have implemented fermenting techniques, and according to the region and differences in dietary life, they use the soybeans in liquid, paste, or mixed forms.

The traditional fermented products that use soybeans can be largely categorized into cases where fungi and Bacillus sp. are used. Food that uses fungi is widespread in East and Southeast Asian countries such as Korea, Japan and Indonesia. In Indonesia, Tempeh is unique. Bacillus is widely used in fermented foods in many Asian countries such as India, Nepal, and Cambodia. Fermenting with Bacillus produces viscous substances, and these products include Natto (Japan), Chongkukjang (Korea), Knema (India, Nepal, Bhutan), Thua nao (Thailand), Pepok (Myanmar) and Sieng (Cambodia, Laos) [5]. Most of these fermented products, soybeans are soaked in water, and then cooled down moderately. They are put in a big basket and fermented for three to five days at around 25–40 °C. The kind of soybean that is used differs depending on the country, but Bacillus is usually used for fermentation.

Fermented products in Korea that are produced and distributed in Korea are different from other East Asian countries. In Korea, Meju (dried soybean block) is used to produce products such as Kanjang, Doenjang and Gochuchang (Fig. 1). Traditionally Chongkukjang (also written as Chungkukjang) was made by fermenting the cooked but non-crushed soybeans for two or three days in the living room, usually they prepared Chongkukjang in autumn and winter after harvesting soybeans. Traditionally making Meju for living room, usually they prepared Chongkukjang in autumn and winter before harvesting soybeans. Traditionally making Meju for Kanjang and Doenjang, most often by the women of the household in late fall during the harvest season is hard working. Doenjang and Kanjang, most often by the women of the household in late fall during the harvest season. Both Meju and soybean in the household in late fall during the harvest season is hard working. Doenjang and Kanjang, which makes up 50 to 70% of the nitrogenous, are used in the household in late fall during the harvest season. Meju and soybean are aged for longer periods [4]. Gochujang (Kochujang in 2, see the previous paper by Kwon et al in this issue) is a unique and representative Korean traditional food for more than a thousand years [6]. Gochujang was usually prepared by mixing powdered red peppers, powdered Meju, salt, malt-digested rice syrup, and rice flour, and the mixture matured for more than 6 months (7). For Meju, fungi and Bacillus sp. are used in the fermentation process and they make the enzymes that are needed. The enzyme breaks down the proteins while maturing and produces different tastes and aromas. Chongkukjang only uses Bacillus to produce the tastes that are similar to other fermented products. The Meju is fermented outdoors during the winter and dried in the sunlight during the spring.

As shown Table 1, the microorganisms involved in the fermentation process include the following variety: Meju mold, molds isolated from Meju, yeast, and bacteria [8].

### 3. Manufacturing and functionality of fermented soybean products

#### 3.1. Kanjang

Kanjang is one of the representative fermented products, and it is the most widely known fermented soybean seasoning. The fungus that proliferates from the Meju and the enzyme created from Bacillus breaks down the soybean protein and produces the amino acid that creates its savory taste. The amino acid produced during the fermentation process reacts with the saccharides and produces a brown substance called malanoidine by Maillard reaction [9]. As a result, the Kanjang’s distinctive color is created. Japan has contributed to the globalization of Kanjang, but the use of fermented products was already widespread before modern times and Baekje Kingdom period (Baekje is one Three Kingdom Peninsula, AD 600) [10].

As shown in Fig. 1, Kanjang and Doenjang are traditionally made through the same process. Normally, fermentation and maturation takes from three months to six months. However in industrial method, Kanjang produced with defatted soybean and wheat flour using koji inoculated Aspergillus oryzae, and soaked and then matured independently Doenjang process. The main ingredients of Kanjang are amino acid, peptide, saccharides, and alcohol created during the maturing process, and organic acid, which affects both the taste and the aroma. There are significant differences in the aroma and content between the traditionally made and institutionally made Kanjang. The savory flavors of Kanjang come from the free amino acid that makes up 50 to 70% of the nitrogenous. Usually the glutamic acid has a significant effect. For Kanjang, the effect of antioxidants from the fermentation process is known to prevent cancer [8].

#### 3.2. Doenjang

As described before, traditional Doenjang is made with the process shown in Fig. 1, where the liquid is divided to make Kanjang, and the solid is collected. For further fermentation, put more cooked cereals and Meju into it and matured for three to six months, Doenjang is made. Fungi proliferates in the Meju, and the enzymes created from the Bacillus play the main role for maturation. The final Doenjang product is usually light brown, and served as paste that turns darker over time due to chemical reactions like as Maillard reaction [9]. It is mostly used for soups and sometimes eaten with vegetables.

Koreans eat Doenjang in the form of soup every day [11], and the amount consumed daily is about 8.8 grams. When preparing the soup, garlic, onions, and red pepper powders are sometimes added to enhance the Doenjang flavor.

#### 3.2.1. The functionality of Doenjang

The soybeans that are used as the ingredient for Doenjang have special functional components. They contain isoflavone, which is categorized as phytoestrogen. Here, 12 isomers [10] such as daidzein, genistein, glycitein exist (10), and they all have different functionalities [12].

Generally, the anti-cancer effects of Doenjang come from the trypsin inhibitor, isoflavone, vitamin E, and linoleic acid, which is an unsaturated fatty acid that contributes to biological activity [13]. Also, the Doenjang extract vitalizes the glutathione S-transferase, which aids in the detoxification of the liver. It also increases the vitalization of natural killer cells [14]. When the maturation period is extended, glycosylated isoflavone converts into genistin, daidzein that are aglycone. The tumor control effect [15,16] being increased can be witnessed (Table 2). By taking the fermented Doenjang, di-peptide as arginine-proline, which have the abilities to produce an ACE (angiotensin converting enzyme) inhibitory effect, is also consumed. They are known to prevent high blood pressure [17]. Other peptide substances have blood pressure depressant abilities [18]. Most notably, Doenjang has the ability to control obesity (Table 3), and this effect increases as a result of fermentation [19]. Research has shown that the consumption of Doenjang also enhances immune functions [20] and decreases the Ig E-antibodies that are produced from the
antigen. This also shows the function of improving and preventing allergies [21].

3.3. Gochujang

Gochujang, a spicy paste made primarily from red peppers [7] and soy sauce, is very unique to Korea, and along with rice, has occupied a space in the staple diet of most Koreans for a long time. Gochujang is made mainly of soybean and consists of 10% to 20% of other ingredients, including spicy red pepper powder and small amounts of rice cereal starches. The fermentation techniques used to make these sauces are unique to Korea and cannot be found anywhere else in the world.

The most distinctive characteristic is use of special Gochujang Meju (different one from Doenjang Meju), which is used as the basic component when making Gochujang. The Gochujang Meju

![Fig. 1. The preparation of Korean fermented products from soybeans. (quoted from reference [2]).](image)
contains soybean and wheat, which are sources of proteins and carbohydrates. The microorganisms proliferated in Meju produce the enzymes that hydrolyze protein and starch. The traditional Gochujang Meju usually takes two to three months for natural fermentation with wild microorganisms. After fermentation, the remaining dried and pulverized substance is used as the main source of Gochujang. Usually, rice is saccharified by malt, and Gochujang Meju powder, powdered red pepper, and Kanjang are all added to make the paste. Next, it goes through fermentation. The fermentation period normally takes three to six months, and during this period, protein and starch is decomposed to produce a umami (savory) and sweet flavor as shown in Fig. 1.

Compared to other fermented products, Gochujang uses a variety of ingredients. Thus, the microbes involved are not simple. Normally, the amount of Bacillus is $10^7$ to $10^8$/g, and the altered Bacillus that are detected are Bacillus velezensis-B. amyloliquefaciens>B. subtilis [7]. For halophilisms, B. licheniformis and B. velezensis are confirmed. As for yeast, Zygosaccharomyces rouxii are the main components and Candida apicola and Z. beilli are also found. Sometimes, halophilism is detected as well. In other research results, B. licheniformis and B. subtilis were found in traditional Sunchang Gochujang, and the range of the total amount of Bacillus was 6.6 to 8.38 log CFU/g [22]. For fungi, Aspergillus are the microorganisms that can act first, and Penicillium and Rhizopus have worked.

Different functionality of Gochujang has been known through the red pepper’s capsacin and soybean’s fermentation product. There have been many studies that show its effects in preventing obesity [23,24]. The spicy flavor of the red pepper and capsacin stimulate the spinal cord and accelerate the adrenal adrenaline secretion, also expediting metabolism and breaking down body fat [25] (Table 4). Some clinical data shows that Gochujang, together with capsacin and the fermentation product, has a connection to weight loss [26]. In an experiment where Gochujang pills were consumed, the abdominal fat and subcutaneous fat decreased significantly, so a decrease in weight due to the consumption of Gochujang is evident. The total cholesterol (TC) and low density cholesterol (LDL-C) in the blood decreases significantly [27], and the result shows that bad lipids in the blood decrease as do stress levels. Recently, thus, European and other Western countries have shown great interest in Gochujang. Some research has been conducted that focuses on the evaluation of the consumer function Gochujang has for Europeans [28].

### 3.4. Chongkukjang

Of the fermented products, Chongkukjang has the shortest fermentation period (2–4 days) and is fermented at a high temperature (40 to 43°C). The history of Chongkukjang production dates back to B.C.E., but the oldest on record, Si(ক), dates back to the period of the Three Kingdoms (C.E. 683). So it can be inferred that even before this time there were fermented products. Chongkukjang has its soybean protein degraded from the protein degradation enzyme, and free amino acid is produced along with related peptides afterward. Because of this, Chongkukjang has its own special characteristic and aroma. It also serves as a great source of nutrients that provide adequate amounts of amino acid in Korean people’s diets, where rice constitutes a common and substantial part of most meals. Chongkukjang only takes about 3–4 days to make. It is fermented straight from boiled soybeans, unlike Doenjang and Gochujang, which use fermented Meju. As a result, it requires considerably less time to prepare (Fig. 1).

### Table 2

<table>
<thead>
<tr>
<th>Sample</th>
<th>Tumor (g)</th>
<th>Inhibition (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sarcoma 180 Cancer Cell(24) + PBS (phosphate buffered saline)</td>
<td>5.8 ± 0.3</td>
<td>–</td>
</tr>
<tr>
<td>A: Doenjang (3 month)</td>
<td>5.4 ± 0.2</td>
<td>7</td>
</tr>
<tr>
<td>A: Doenjang (6 month)</td>
<td>4.7 ± 0.3</td>
<td>19</td>
</tr>
<tr>
<td>A: Doenjang (24 month)</td>
<td>3.6 ± 0.2</td>
<td>38</td>
</tr>
</tbody>
</table>

※ Shows the significant difference in a-c Duncan’s multiple range test (p < 0.05).

### Table 3

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Normal rat</th>
<th>High-fat diet</th>
<th>High-fat diet + Doenjang</th>
<th>High-fat diet + Chongkujang</th>
<th>High-fat diet + Gochujang</th>
<th>High-fat diet + samjang</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial weight</td>
<td>143.7 ± 3.9</td>
<td>143.7 ± 3.9</td>
<td>143.8 ± 4.1</td>
<td>143.7 ± 3.9</td>
<td>143.9 ± 4.5</td>
<td>143.7 ± 5.0</td>
</tr>
<tr>
<td>Final weight</td>
<td>259.0 ± 16.1</td>
<td>295.1 ± 11.6</td>
<td>251.3 ± 22.3</td>
<td>277.1 ± 13.8</td>
<td>270.5 ± 5.4</td>
<td>261.1 ± 17.4</td>
</tr>
<tr>
<td>Weight increment</td>
<td>3.9 ± 0.6</td>
<td>4.8 ± 0.4</td>
<td>3.8 ± 0.3</td>
<td>4.2 ± 0.5</td>
<td>4.2 ± 0.1</td>
<td>4.0 ± 0.2</td>
</tr>
</tbody>
</table>

1. Significant difference in a,b,c,ab,bc Duncan’s multiple range test (p < 0.05).
2. Values are expressed as means ± SE.
3. Values in each column represent differences between the mean changes and scores of the Doenjang group and those of the placebo group.
4. Values derived from repeated measures analysis (per protocol) after adjusting for age, gender and BMI.

### Table 4

<table>
<thead>
<tr>
<th>Body weight</th>
<th>ND (1)</th>
<th>HFD (2)</th>
<th>CK (3)</th>
<th>TK I (4)</th>
<th>TK II (5)</th>
<th>RPP (6)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial weight (g)</td>
<td>199.9 ± 7.5</td>
<td>198.0 ± 6.4</td>
<td>198.6 ± 7.1</td>
<td>200.7 ± 9.6</td>
<td>199.9 ± 9.7</td>
<td>199.9 ± 2.7</td>
</tr>
<tr>
<td>Final weight (g)</td>
<td>338.8 ± 0.5</td>
<td>382.8 ± 1.4</td>
<td>358.4 ± 4.4</td>
<td>362.6 ± 2.5</td>
<td>354.5 ± 0.1</td>
<td>376.5 ± 5.1</td>
</tr>
<tr>
<td>Weight (mg/day)</td>
<td>4.4 ± 0.2</td>
<td>6.4 ± 0.1</td>
<td>5.7 ± 0.1</td>
<td>5.8 ± 0.4</td>
<td>5.8 ± 0.5</td>
<td>6.2 ± 0.2</td>
</tr>
</tbody>
</table>

Significant difference in a,b,c,ab,bc Duncan’s multiple range test (p < 0.05).
1) Normal diet (AIN-76TM).
2) High fat diet (contains 20% corn oil in normal diet).
3) Commercial diet : C Co.
4) Traditional Gochujang diet I: 0 day fermented Gochujang (Sunchang Gochujang Village).
5) Traditional Gochujang diet II: 6 month fermented Gochujang (Sunchang Gochujang Village).
6) Red pepper powder (3%) diet (red pepper content of 10% Gochujang added high fat diet).
3.5. Other traditional Korean fermented foods

Korea has a few other kinds of complex fermented dishes. A few of those that use soy sauce are listed below [7].

*Eoyukjang*: The haunch of cow, chicken, gray mullet, and sea bream are dried and then put into Meju along with abalone, mussel, shrimp, egg, ginger, green onion, and tofu. Using these ingredients, the same steps for making Kanjang is followed.

Fermented dried pollack: *Hwangtae* soybean is steamed, and the Meju is shaped like a hilt with bean leaves floating on the top. With this Meju, a fermented product is produced.

*Chongyukjang*: Fried soybean is boiled and from this a solution is produced. Next, soybean is added to the solution it is boiled with beef, white radish, and red pepper for three to four days.

*Juebjang*: Meju is made with wheat bran and fried soybeans. Is it then shaped into walnut-sized pieces and steamed with mulberry leaves that float. Cucumbers and eggplants may be added and then fermented together.

4. Discussion

On the Korean peninsula, the history of production of soybeans dates back to B.C.E. Soybeans make great seasoning and used in soups and side dishes. Since the origin of soybean dates back to Manchuria (*Kochosun*), Korean people and soybeans have an inseparable relationship. As a result, Koreans have developed many ways to use soybeans.

Soybeans can be eaten in their natural form, with rice, by boiling the two together, by frying them in *Kangejong*, or by using them as *Injeolmi* crumbs. Soybeans function as an important source of vegetables during winter, when they are sprouted into bean sprouts. Using another method, boiled soybeans can be used to make Meju. Using Meju, Kanjang, Doenjang, and Gochujang is produced. By exploiting the microorganisms to change the soybean protein, fat, or carbohydrates, into a water-soluble substance, new methods of making new flavors and aromas have been developed. The products created through fermentation have new kinds of bioactive substances that have positive effects on the body. It has been scientifically proven that these products can function to fight off cancer and tumors, as well as prevent blood clots, obesity, diabetes, and constipation.

Looking at these results, the importance of fermented products is clear. More than a seasoning, they have the capacity to function as health aids.

**Conflicts of interest**

The authors have no conflicts of interest.

**References**
