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Utilization of Soybean as Food Stuffs in Korea

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1. Introduction

1.1 Origin of soybean

The origin of soybean is considered as Manchuria and Korean Peninsula and these areas are also the living base of ancient Dongyi tribes. In general, in the estimation of the origin of crops, the presence of its wild species is the most important index in which lots of wild soybeans are found at the present time in these areas. In archaeology, the cultivation year of soybeans is estimated to be about 4,000 years ago. In Korean Peninsula, carbonized soybeans were found at some historic sites in the Bronze Age and that provides evident for such cultivation (Kwon et al., 2005 a). Table 1 shows the historic sites of soybean excavated in Korean Peninsula according to their era.

Remains	Kind	State	Period (Earthenware)
Ohdong, Heryong County, Hambuk	Each grain of soybean, red bean as carbonization	Bottom of habitat site, bronze age	Bronze-Iron age (minmun pottery)
Honam, Samseok section, Pyongyang,	Carbonization grain of foxtail millet, proso millet, sorghum bicolor, soybean	Habitat site of No. 36	Bronze age (top type pottery)
Submerged area, Gyeonggi Paldang	Soybean, red beans		Bronze age
Buwon-dong, Gimhae county, Gyeongnam	Rice, wheat, and husk of soybeans (3 each)	A district, 11 th floor	

Table 1. Unearthed remains of soybean in Korean peninsula

It has been known that the cultivation of soybean was originated from the era of the middle period in the agricultural age of the New Stone Age to the Bronze Age (around BC 1,500). Some pieces of earthenware studded with soybean in the Bronze Age were found at the Paldang submerged area in the suburb of Seoul. Lee Sung-Woo (1988) proposed that the first people that cultivated soybean as a food in the history of mankind is around BC 4000~2000. Also, it is assumed that the first cultivation of soybeans was started in arable fields at the hub of Mountain Baekdu.

It is considered that soybean have been contributed to the table of Dongyi tribes as an important protein source in such primitive ages that show insufficient nutrients. Thus, it can be seen that soybean play an important role in forming the early countries in Northeast Asia due to the increase in military powers on the basis of improving their nutrients (Kwon et al., 2005^a).

1.2 Strain of soybeans and its production

The strains of soybean cultivated in Korea are classified according to purpose that includes soybean for soybean sauces and pastes, soybean sprouts, boiled rice, early-ripening beans, unripe beans, and premium strain.

The strains of soybean for soybean sauces and pastes are a total of 43 varieties and distributed from Jangeup in 1978 to Joongmo 3003 in 2009 (National Institute of Crop Science, Rural Development Administration, Korea). As new strains of soybean have been distributed every year as a similar way to that of red peppers it is necessary to continuously conduct studies on the proper strains of soybean for soybean sauces and pastes. The production of soybean is about 130~180 thousand tons per year even though it is varied according to its harvest (Table 2).

Year	Area(ha)	Production(ton)
2004	85,270	138,570
2006	105,421	183,338
2008	75,242	132,674
2009	70,264	139,251

Table 2. Soybean production and cultivation area by year

The essential ingredients of soybean are protein (30~50%) and fat (14~24%) where the protein covers the largest portion of such ingredients. About 63~90% of the soybean protein are glycinin included in globulin, and the other components are phaseolin (17%) and legumelin. These are a type of water insoluble protein that is solved in a salt solution and represents no specific taste (Snyder et al., 1987^a; Liu, 1997^a). Although a sulfur containing amino acid is a limiting factor in an amino acid that is an ingredient of protein, it has abundant lysine, which is insufficient in cereal protein, and helps to intake balanced nutrients as it is taken with some cereals due to their interaction.

Although the protein of soybean has no specific component in presenting its own taste, it represents several savory tastes as it is dissolved into the types of amino acid and peptide and that may be used as various seasoning sources. A fermentation process that multiplies molds or bacteria after cooking soybean dissolves soybean protein using protease in order to obtain amino acids and peptides for resenting such savory tastes.

Regarding the uses of soybean in Korea, these uses are divided into two large different ways such as a direct use and a dissolving process of the protein of soybean through a fermentation process. In the dietary life in Southeast Asian countries, the soybean fermentation technology that obtains seasonings are already developed very well.

As mentioned above, the fermentation technology using soybean has been used since a great while ago and that represents a rich variety of products in Southeast Asian countries. The fermented soybean products in Korea are largely classified as soybean sauces and pastes such as Ganjang(soy sauce), Doenjang(fermented soybean paste), Gochujang(fermented red pepper soybean paste), Dambukjang(admixture of soybean paste with other seasonings), and Cheonggukjang(fermented soybean paste by *Bacillus*). Thus, such fermented soybean

products are fairly-well known as a common name in the foods of soybean sauces and pastes. Fig. 1 shows the classification of the uses of soybean in Korea.

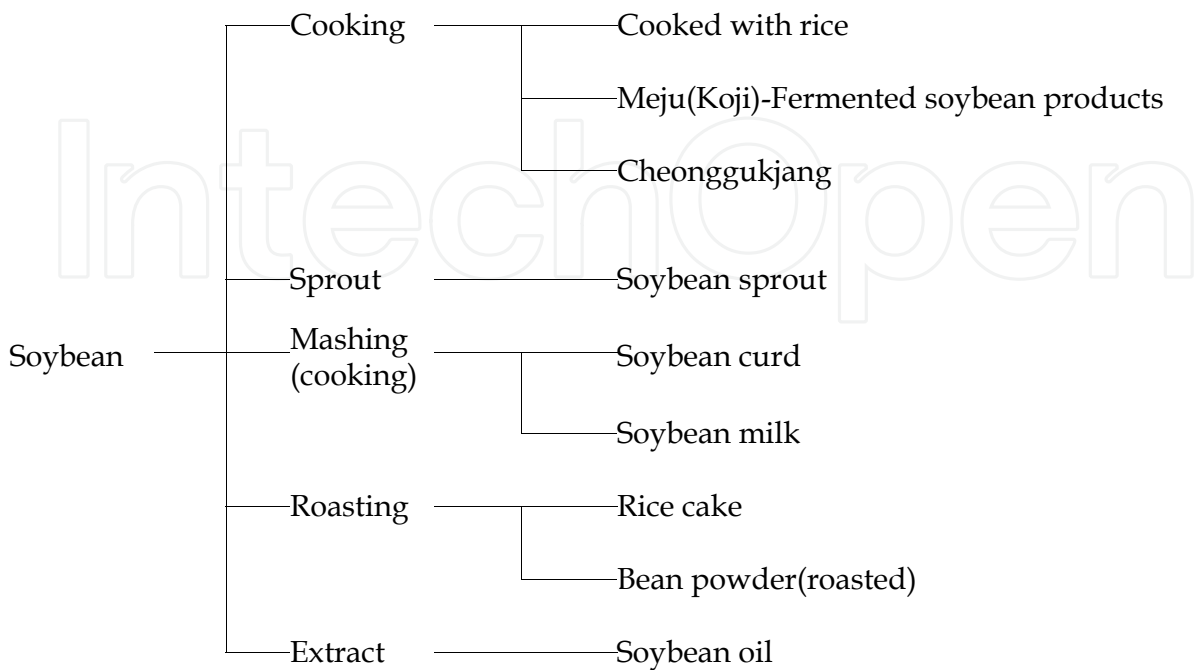


Fig. 1. Classification of soybean products in Korea

2. Non fermented soybean products

2.1 Soybean sprout

Soybean sprout are a type of vegetable that cultivates soybean in a dark place after soaking in water and sprouting soybean as a unique manner. In general, soybean sprouts represent soft tissue and yellowish white color because they are grown in a dark place. The history of soybean sprouts for food use goes back to before the age of the Three States (at ancient Korean history). Although the record presented in the Hyangyakgugeupbang, which was published in King Gojong, Goryeo Dynasty, it is estimated that the period goes back to long before the Century (Kwon et al., 2005^b; Jang, 1993^a).

As soybean sprout (Photo. 1.) represent a characteristic of vegetable, it can be used in various Korean cuisines such as soybean sprout soup, boiled rice with soybean sprout, boiled rice with assorted mixtures (bibimbap), and soybean sprout salad including their flavoring roles in various stews.

As mentioned above, as soybean sprout in various cuisines show excellent nutritional characteristics, it represents several advantages as low caloric, low saturated fatty acid, non-cholesterol, and high dietary fiber foods (Hwang, 1995).

Regarding the characteristics of soybean sprout, it can be cultivated without sunlight and shows a short period of growth within seven days at 20~22℃. Also, soybean sprout can be cultivated regardless of locations and season if possible growth conditions are configured. In particular, soybean sprout have been used as one of the most familiar vegetables for Koreans due to its low price and nutritional aspects, which include abundant protein, fat, vitamins, active minerals, and so on (Park, 1991; Kim et al., 1993). Table 3 shows the comparison of the nutrition facts in soybean sprout.



Photo. 1. Growing of soybean sprout

Ingredients		Soybean	Soybean sprout
Moisture(g)		9.7	89.3
Protein(g)		36.2(40.1)	5.3(49.5)
Fat(g)		17.8(19.7)	1.2(11.2)
Carbohydrate(g)	Sugar	25.7(28.5)	2.8(26.2)
	Fiber	5.0(5.5)	0.6(5.6)
Ash(g)		5.6(6.2)	0.8(7.5)
Calcium(mg)		245(271)	26(243)
Phosporus(mg)		620(687)	81(757)
Iron(mg)		6.5(7.2)	0.8(7.5)
Vitamin	A(I.U)	0	0
	β-carotein(μg)	0	
	Thiamine(mg)	0.53(0.6)	0.14(1.3)
	Riboflavin(mg)	0.28(0.3)	0.11(1.0)
	Niacin(mg)	2.2(2.4)	0.6(5.6)
	C(mg)	0	13(121)

* weight / 100g () : weight/100g dry base

Table 3. Nutritional value of soybean and soybean sprout (Kim, et al, 1993)

The Vitamin C contents in the special nutrition facts of soybean and soybean sprout are presented in Fig. 2 (Kim et al., 1993). As shown in Fig. 2, the vitamin C contents largely increase during the growth period of soybean sprout in which it is not detected in the early stage of the growth but shows the maximum level at the seventh day as 18mg/100g. In the results, it shows the vitamin C can be newly produced through its entire growth period. In addition, changes in the generation of asparagines, which is one of the particular ingredients in soybean sprout, are presented in Fig. 3 (Yang et al., 1977).

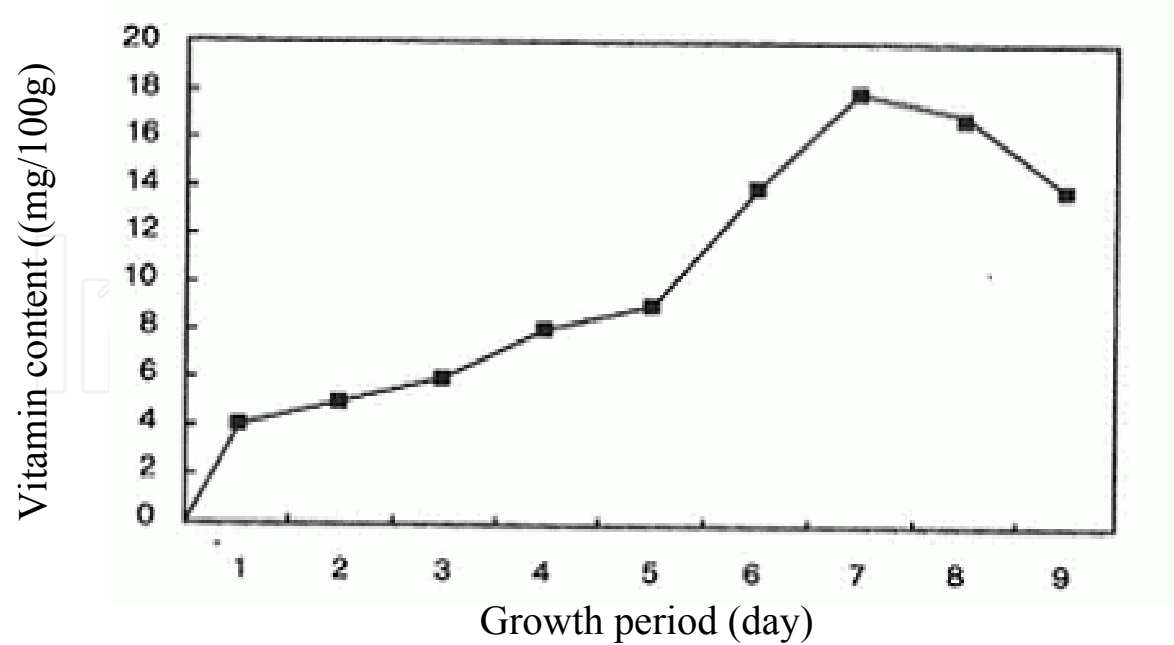


Fig. 2. Vitamin C content during sprouting of soybean (Kim, et al, 1963)

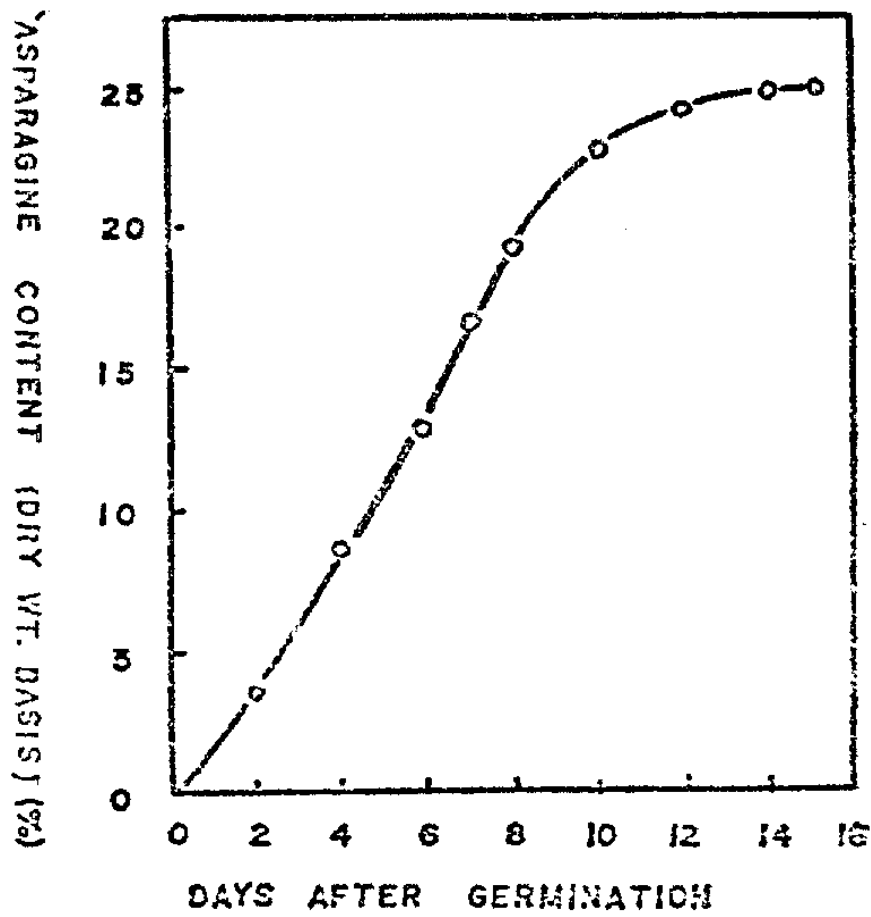


Fig. 3. Asparagines formation during soybean sprouting

As illustrated in Fig. 3, the asparagines contents in the growth period of soybean sprout significantly increase after six days of starting the growth and show up to 22% of the amount of dried one after 10 days of starting the growth.

In addition, the isoflavone contents largely increase during the sprouting period of soybean sprout (Kim et al., 2004). Based on these results, it shows that the special functional ingredients in soybean are newly created during its growth period.

Soybean sprout in Korea have been used as sub-materials in various cuisines, such as boiled rice with assorted mixtures, boiled rice ball with soybean sprouts, stews, and soups, as exquisite foods (Lee, 2005).

2.2 Soybean curd (Tofu)

Soybean curds show a long history in its dietary uses in Korea, China, and Japan and have currently been sold in western markets. In particular, soybean curds have been playing roles in supplying excellent protein sources to the consumers who are lack of animal proteins in these countries.

Literatures on soybean curds were recorded about 2,100 years ago at the era of Hoenam King, Han dynasty, China, and showed the propagation of soybean curds to Korean Peninsula before the end of the era of Goryeo Dynasty (Kim, 2005).

Then, the production technology of soybean curds was propagated to other neighbor countries since the era.

The reason that the soybean curds have been used in recent times even though it has such a long history is considered as its unique taste and particular texture (Jang, 1993^b)

The chemical composition of soybean curds are about 80~85% of water, 8.5% of protein, 5.5% of fat, and 1.5% of ash in which protein covers a high portion of about 42~52% in its solid part. The nutrients included in soybean curds are essential amino and fatty acids required by the human body. Also, soybean curds include some active minerals such calcium, iron, and so on. Fig. 4 shows the process of producing soybean curds (Jang et al., 2008).

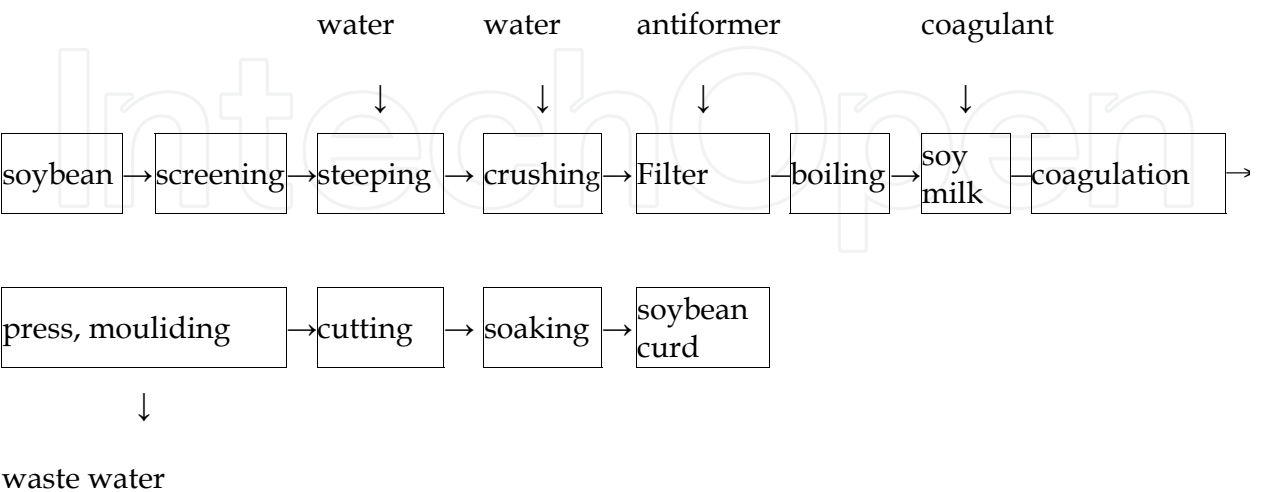


Fig. 4. Manufacturing process of common soybean curd

The major soybean curd products produced in Korea are regular soybean curds, coagulated bean curds, and soft soybean curds. The most largely produced regular soybean curds represent soft texture and rectangular shapes, and have the characteristics of simple taste and flexible resilience. The soft soybean curds represent satiny surfaces and very soft textures. The coagulated bean curds partially include some solid parts in a liquid phase. Although such soybean curds are directly taken, soybean curds are usually processed as stews, soups, soybean curds pancakes, and soybean curds dumplings. The daily intake of soybean curds in Korea has been recorded as 24.5g per person (National Health and Nutrition Examination Survey, 2005). Thus, a lot of people in Korean take soybean curds every day as a large sum.

2.3 Creamy soybeans (Soy milk)

Soybean curds are produced using coagulants after grinding and filtering soybeans, and the phase before applying the gelling agent is called creamy soybeans or soybean juice (Kim, 2005). As the creamy soybeans were mentioned in the Hyangyakgugeupbang, which was published in King Gojong (1236), Goryeo Dynasty, it is estimated that the creamy soybeans had already produced by average people in the era of the Unified Shilla(an old country in Korean peninsula) .

Although creamy soybeans are produced by grinding steamed soybeans or by grinding just after applying water immersion, it can be regarded that the grinding and filtering of soybeans are used in the early stage of producing such creamy soybeans (Jang, 1993a). The creamy soybeans include several functional substances and then considered as good nutritious foods for preventing chronic diseases (Lee et al., 1997). Creamy soybeans are directly taken as a type of beverage and have been largely known as Korean exquisite foods that are usually prepared with other foods including noodles, such as creamy soybean noodles. Fig. 5 illustrates a simple process for producing such creamy soybeans (Jang et al., 2008).

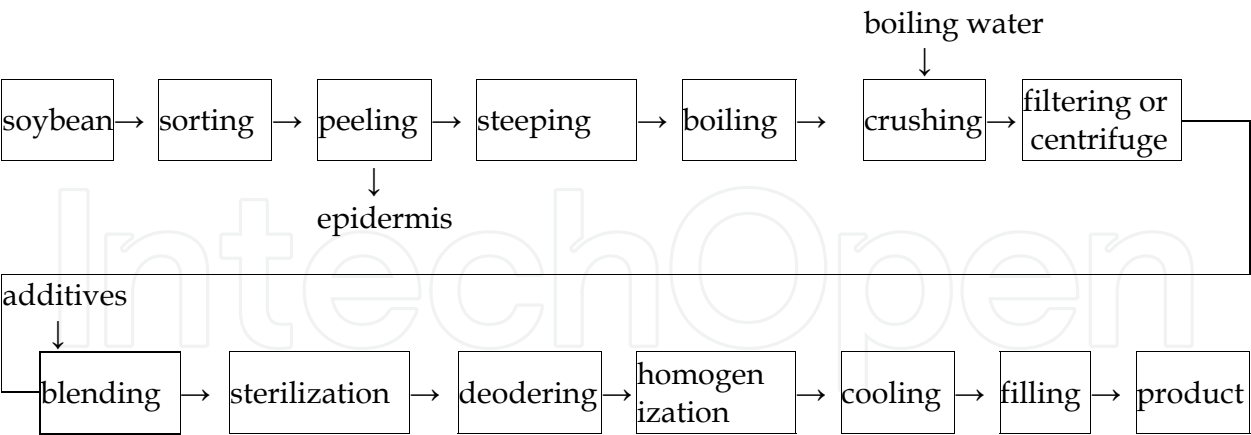


Fig. 5. Processing procedure of soybean milk

2.4 Other soybean products

There are many soybean used as foods in Korea. Some foods use soybeans directly such as soybean Gangjeong(a kind fried glutinous rice or soybeans), Jorim(boiled soybean with seasonings) and roasted soybean powder for making rice cake. Also, soybeans have been used as several purposes for increasing tastes by grinding and applying it to other rice

products such as soybean rice cakes. In addition, there are lots of homemade soybean used foods (Lee, 2005).

Furthermore, soybeans have been used to compensate the nutrition of rice by mixing it with other different foods including boiled rice and boiled rice with different grains.

Soybean Gangjeong mixed soybean that has been taken as one of the most popular soybean foods is produced by mixing some puffed grains or soybeans with a concentrate malt syrup. Then, the mixtures of soybeans, sesames, walnuts, pine nuts, peanuts, and so on are cut by proper sizes. The concentrate malt syrup mixed with soybean is taken as a snack because they show nutty, sweet, and other particular tastes.

Jorim(boiled soybean with seasonings) are made using black soybeans and boiled in soybean sauces with some starch syrup after immersing soybeans into water. The properly Jorim are taken as a side dish of boiled rice. Soybeans applied to rice cakes contribute to softening its texture and to improving taste.

Roasted soybean flours are used to produce rice cakes, such as glutinous rice cakes, using the dough of glutinous rice by mashing it using a wooden hammer. Then, the rice cakes are coated with roasted soybean flours and cut by proper sizes. Rice cakes have been contributed to all types of ceremonies including some happy events and sacred rites and then the cakes are distributed to families and relatives. In addition, rice cakes have been recently taken as good snacks.

Roasted soybean flours are produced using a fine mesh in order to obtain fine flours after roasting it with high temperature and grinding it.

Also, oil extraction using soybeans is performed applying a modern method. The soybean oil products have been produced and distributed using imported soybeans, which are about one million ton annually. The remains of soybeans after extraction it are used as feeds or soybean sauces and pastes.

3. Fermented soybean products

Korean traditional foods use agricultural products from a longstanding heritage of agrarian society, and such agricultural products provided by nature have been largely used in practical life due to distinctive four seasons. In particular, the dietary life was determined based on the principle food of rice and then cultures with boiled rice were already settled in B.C. Also, some side dishes were also introduced as the major elements in the dietary life. In addition, some subsidiary food materials that provide specific flavors to boiled rice, which has no particular taste, were required and then subsidiary foods were also developed. However, vegetables were not properly used as such side dishes for boiled rice because these vegetables showed no flavors. Thus, certain brining methods for these vegetables were introduced and developed. By introducing brining methods in Korea, it was an occasion that the dietary life in Korea was changed to fermentation based diets.

Fermented foods in Korea have been formed as the principle foods in Korean dietary life where there are no foods that do not use fermentation methods in diets directly or indirectly. Also, fermented products play important roles in determining the tastes of foods. In particular, such brining and fermentation methods have been used as a way for spending a winter season, which has no vegetables, and are the chances to form the characteristics of dietary cultures in Korean people. In addition, for presenting tastes, savory, sour, and sweet tastes are created based on the fermentation by salts and that contributed to represent the originality of Korean foods (Shin, 2008).

Therefore, the food cultures in Korea cannot be considered by excluding the fermented foods, and Korean traditional foods should be discussed on the basis of the characteristics of fermented foods. That is, the dietary culture of fermentation becomes the basic fabric of Korean foods and takes a large part of life.

Table 4 shows the products that can be produced using fermentation methods.

Variety	Sub division	Typical products
Fermented foods	Fermented food	Agro-products(Fermented soybean products, Kimchi, Pickles), Marine products(Jeotgal), Live stock and dairy products
	Alcoholic liquor	Grain liquor, fruit liquor, Beer
Fermented products	Primary products	Amino acids(MSG, lysine), nucleic acids(IMP< GMP), organic acids(citrate, succinate, lactate, acetate, gluconate)
Fermented products	Secondary products	Antibiotics, pigments, toxin, alkaloids
	Health materials	Probiotics, vitamin, oligosaccharides, polysaccharides
	Derivatives	Amino acids(>3000), nucleic acids, organic acids(PLA, PSA)
Enzymes	Physiological	edible, medicine, industrial, restriction endonucleace

Table 4. Various products from fermentation technology

As shown in Table 4, lots of products can be produced using such fermentation methods. This section describes fermented products produced by using soybean in Korea.

3.1 Traditional Ganjang (soybean sauces) and Doenjang (fermented soybean pastes)

Soybean sauces are classified into traditional soybean sauces and improved soybean sauces. These two soybean sauces show very different production processes. For producing traditional soybean sauces, it is necessary to produce Meju (fermented soybean lump). Traditional Mejus are made by housewives in average households and handed down to the present time.

3.1.1 Production process of traditional Meju

1. Preparation: Soybeans are boiled with water for 3~4 hours after washing it. The soybeans should be fully cooked and that becomes an important factor for deciding the quality of Mejus.
2. Meju shaping and molding: The cooked soybeans are shaped as a proper size (usually 15x15x20cm) by hand after mashing it. The shaped soybeans lump, Mejus, are to be fermented for 4~5 days at room temperature after drying its surface. The fermentation is to be carried out at 25~30℃ for 1~2 months.
3. Maturation: In the fermentation process, drying of Mejus is continued and then bacteria and molds are naturally generated. Then, fermentation and maturation are proceeded at the same time. During the drying of Mejus, there are some apertures on Mejus. The fermentation and maturation are continued through winter.
4. Storage: Finished Mejus are dried in sunlight and stored. Finished Mejus are used as the materials of soybean sauces and pastes.

3.1.2 Production of Ganjang (soybean sauce)

1. After preparing Mejus followed by the mentioned process, Mejus are to be washed using water and dried again. Then, dried Mejus are soaked in brine (18-19Be'). The ratio of Mejus:salt: water is determined as 1:1:3. For maintaining a uniform quality, the concentration of brine and the ratio of Mejus to brine are to be specifically determined. Also, Mejus should be immersed under the brine because it floats on the surface of brine.
2. After soaking Mejus in brine, some red peppers and charcoals are applied to the brine in order to prevent bad smells and germs.
3. Mejus soaked in brine are to be matured for about 60 days at a sunny place and occasionally open the cover of the jar for scorching sun light.
4. After soaking Mejus in brine for 70~80 days, Mejus are to be separated from brine using a filtering patch or mesh. The separated solution is used as raw Ganjang, and the separated solid matter is used to produce Doenjang.

3.1.3 Production of Doenjang (fermented soybean paste)

1. Separated Meju masses are to be mashed and mixed with some soybean sauces, Meju flours, and steamed rice or barley according to needs and preferences.
2. Well mixed paste type raw soybean pastes are stored in a jar or pottery and pushed. Then, the post maturation of the stored Doenjang are processed for 3~6 months before using it on the table. Fig. 6 shows the production process of Doenjang.

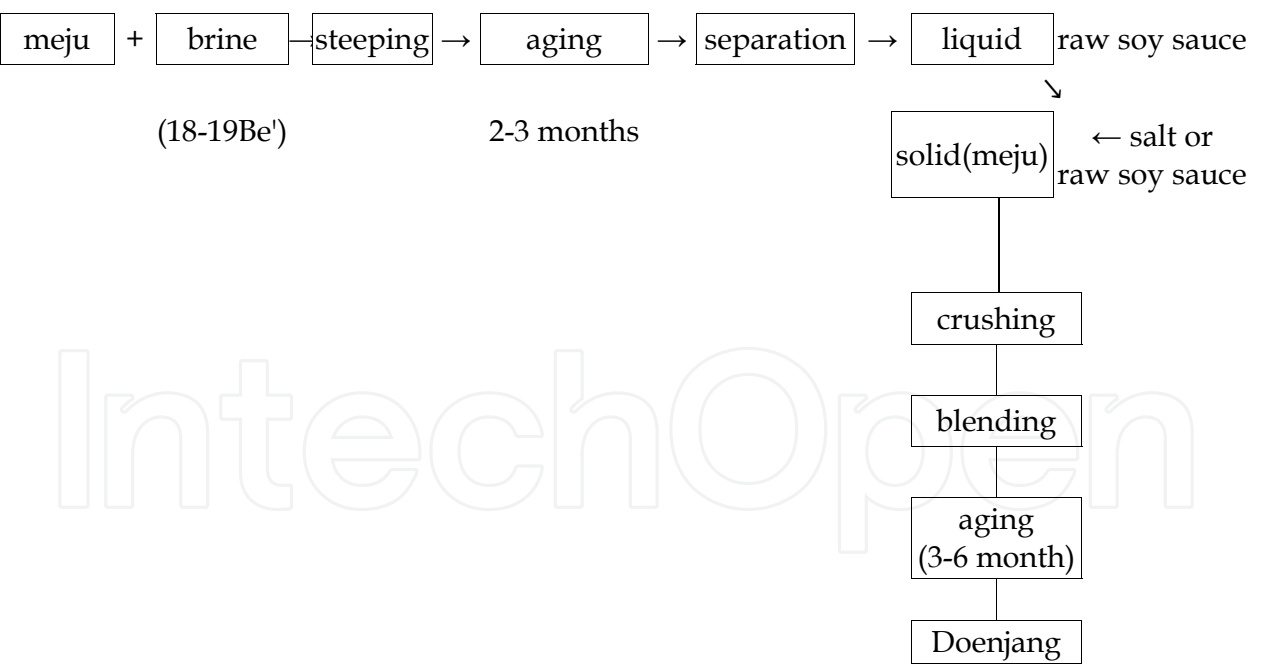


Fig. 6. Process of traditional Doenjang(fermented soybean paste) & Ganjang(soybean sauce)

3.1.4 Improved Ganjang and Doenjang

Korean Ganjang and Doenjang are classified into traditional and improved products. In producing improved products, bacteria and fermentation conditions are fully controlled. Fermentation methods are simply presented in Fig. 7 and Fig. 8.

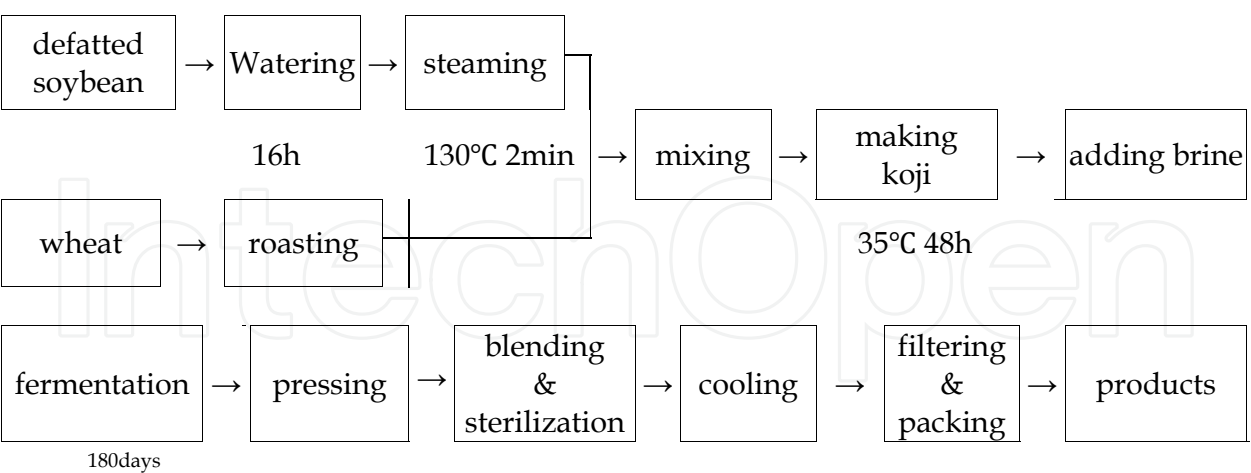


Fig. 7. Common process of Ganjang making

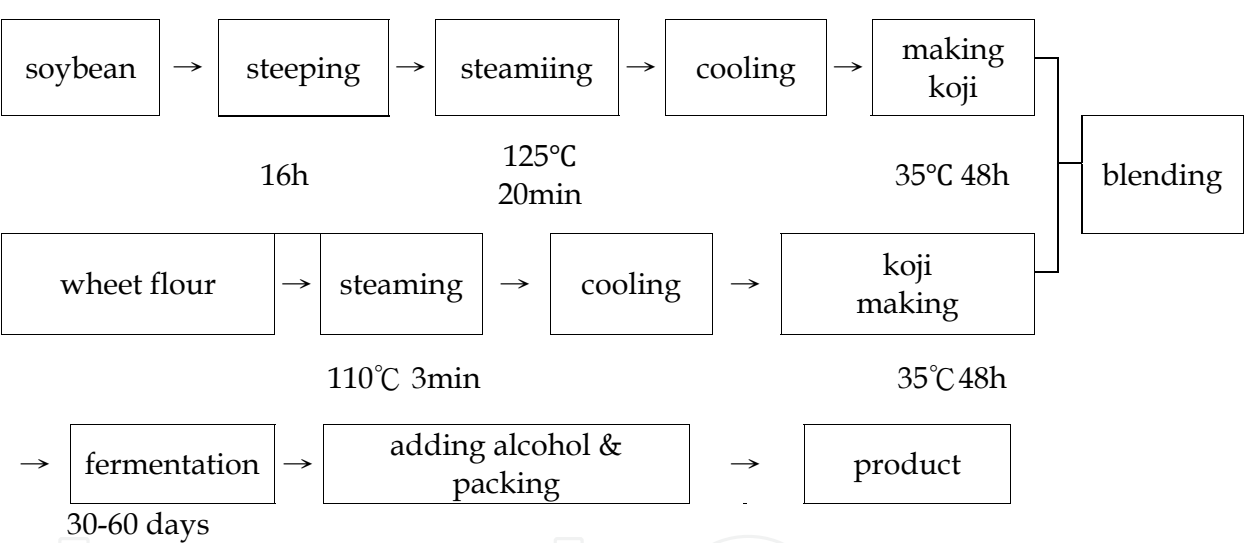


Fig. 8. Common process of Doenjang making

3.2 Gochujang (Fermented hot pepper soybean paste)

For producing fermented hot pepper pastes (Gochujang), the mixture of soybeans and grains (rice and others) are cooked and mashed. Then, the mashed mixture is shaped and fermented by molds and bacteria introduced to make Gochujang Mejus. Then, the mixture of Gochujang Mejus, hot pepper flours, and a digested rice syrup by malt, which is produced using some barley malts, is to be fermented for a long time (Shin et al., 2001; Oh et al., 2001).

Gochujang products are divided into two categories such as traditional Gochujangs produced by using traditional fermentation methods and improved Gochujangs produced by improved methods for mass production. Traditional Gochujangs are usually produced by natural fermentation, and improved Gochujangs represent different ways in managing microbes and fermentation conditions.

Recently, Gochujang products are made by housewives in average households and produced by middle and large factories based on traditional methods. Improved Gochujangs are produced in a mass production system and cover almost 80~90% of Gochujang markets in Korea. Traditional Gochujangs are usually sold to middle aged consumers, and improved Gochujangs are largely consumed because its major markets are young people and food service businesses.

3.2.1 Production of traditional Gochujangs

1. Production of Gochujang Meju
The mixture with the mixing ratio of soybeans to rice as 6:4 is to be cooked and mashed. Then, the mashed mixture is formed as a donut shape and to be matured and fermented at room temperature for 2~3 months. The fermented Gochujang Mejus are to be dried and powdered for storing it. It has been known that Gochujang Mejus are processed and fermented by *Aspergillus* species and *Bacillus subtilis* (Oh et al., 2001)

3.2.2 Production process of Gochujang

1. Traditional Gochujang
Fig. 9 shows a general process for producing traditional Gochujangs.

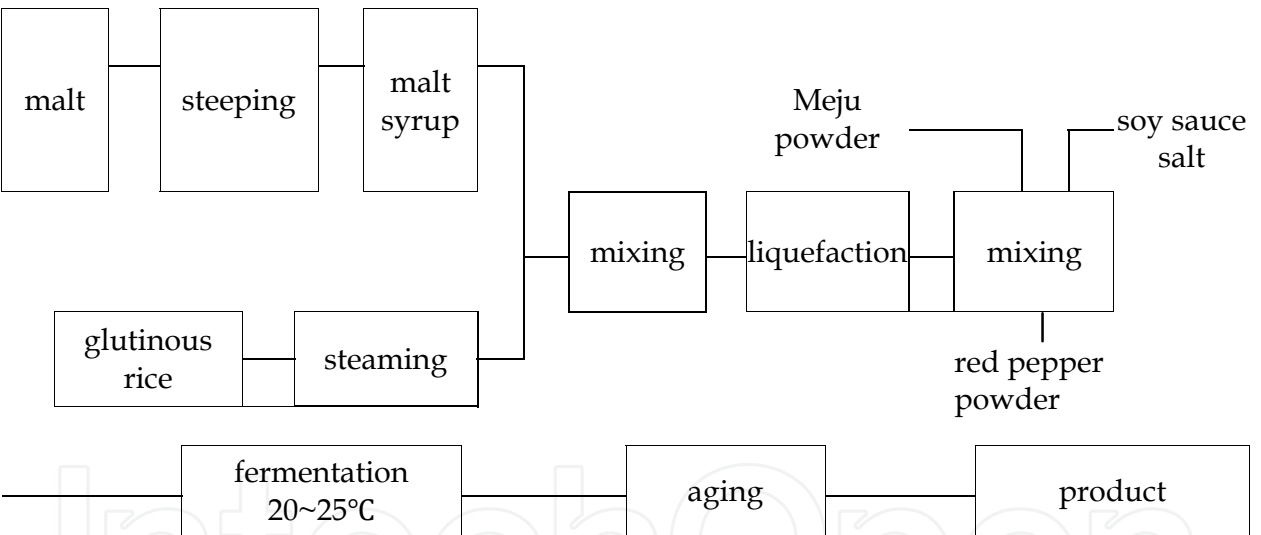


Fig. 9. Process of traditional Gochujang making

2. Improved Gochujang
A basis for Gochujang is to be prepared and mixed with some flours, rice, and starch sources. Then, the mixture is to be fermented. Pure microorganisms are used to produce the basis of Gochujang, and *Aspergillus oryzae* and *Bacillus subtilis* are used to improve its taste.

Fig. 10 simply shows the production process of improved Gochujangs.

3. Quality characteristics of Gochujang
The taste of Gochujang represents a spicy taste caused by hot peppers, a sweet taste presented by sugars from starch hydrolysis, and a savory taste due to amino acids, peptides and nucleic acid related substances generated by the dissolution of soybeans. Then, these tastes become a fermented spice mixed with a salty taste generated by salts.

Several molds, bacteria, and yeasts are contributed to the fermentation of traditional Gochujangs, and taste facts are generated by protease and amylase (Kim et al., 1998; Shin et al., 1996).

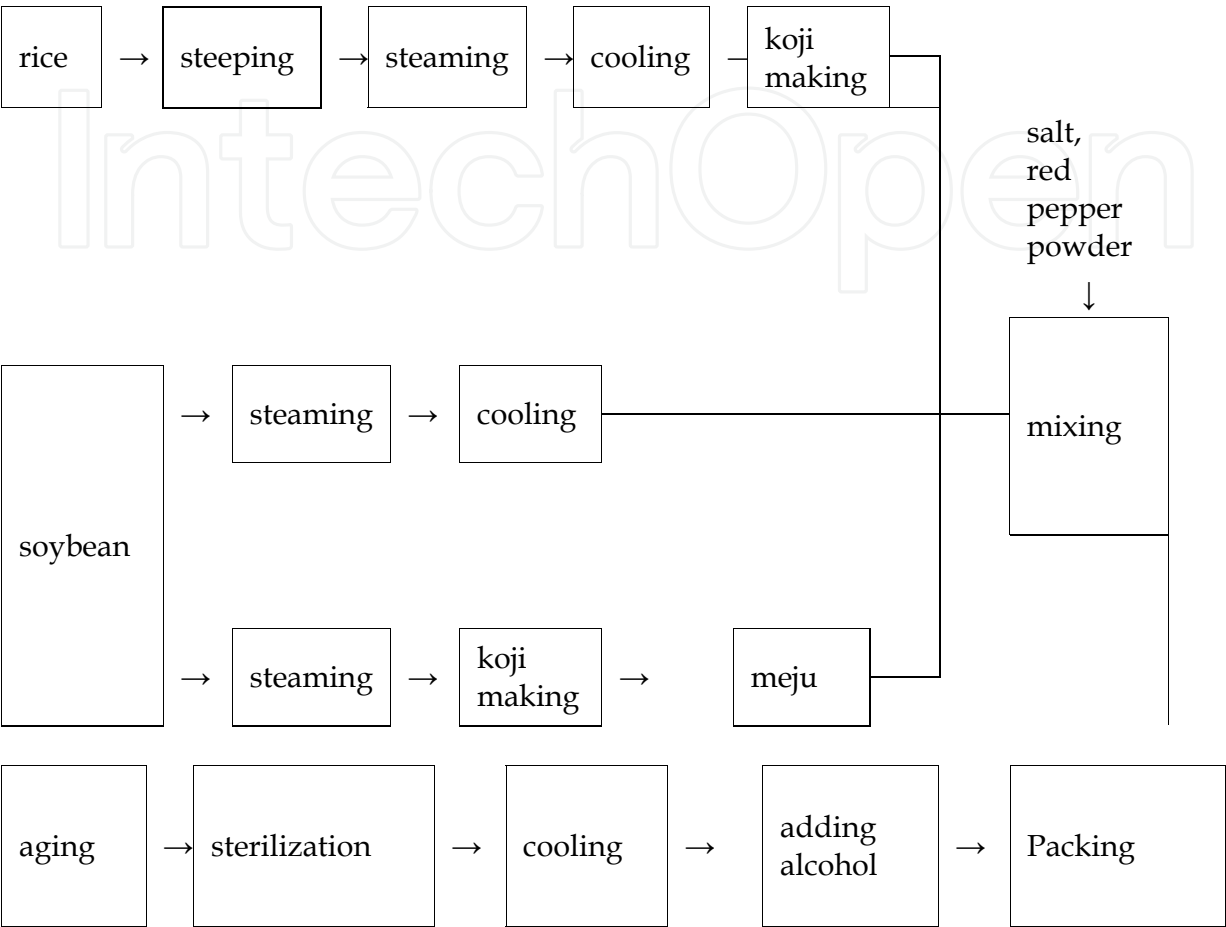


Fig. 10. Production process of improved Gochujang

Therefore, the quality characteristics of Gochujang represent a complex taste with various tastes and are very different according to microorganisms related, fermentation conditions, and materials used.

In addition, various odors of Gochujang including 3-methyl butanol are generated during its fermentation process and that plays an important factor for presenting flavors according to products (Oh et al., 2001).

3.3 Cheonggukjang (Fermented soybean paste by *Bacillus*)

Cheonggukjang is a traditional soybean fermented food that is fully fermented within 2~3 days. Cheonggukjang represent a particular quality characteristic caused by some microorganisms that shows a palatable taste and a unique smell due to the protein generated by protease, which is produced from the proliferation of *Bacillus sp.* In addition, it produces a sticky viscous material. Although there is a similar product in Japan, Natto, to the Cheonggukjang, it shows different fermentation bacteria and dietary usages. Korean Cheonggukjang are usually used in stews and mixed with other foods instead of taking it directly. However, Natto are directly taken.

Various physiological activities in Cheonggukjang have been largely known, and Cheonggukjang have been produced using traditional methods in average households. Also, it has been taken as a side dish in boiled rice. Also, it can easily be produced in households due to its easy production.

3.3.1 Production process of Cheonggukjang

Although fermentation conditions in Cheonggukjang are almost same for traditional and improved products, the differences in these products are whether they use natural fermentation or manage bacteria using a specific way.

The production process of Cheonggukjang is simply presented as follows.

1. Soaking soybean in water

Soybeans are soaked in water for 24~30 hours in winter (0~5°C), 16~24 hours in spring and fall (10~16°C), and 10~16 hours in summer (18~25°C).

2. Cooking soybeans

Soybeans are to be cooked using a pot in households for about 5~6 hours. Also, the steaming can be performed using high pressure steam (1.5~2kg) for about 30 minutes. If soybeans are not fully cooked, the quality of Cheonggukjang is not guaranteed. Also, over cooking shows bad colors and physical properties.

3. Fermentation

Cooked soybeans are to be fermented in a jar. Traditionally some rice straws are inserted to soybeans or used at the bottom and upper sections of the jar for inoculating bacteria. It has been known that rice straws have bacteria, which have high protease activities (Lee et al., 1971).

The use of rice straws represents a certain way of natural inoculation in which *Bacillus sp.*, which has been known as *B. subtilis*, contributes to the process (Lee et al., 2008; Ju et al., 2009). Also, the fermentation takes 30~35 hours at 40~43°C. The fermentation time are largely varied according to temperature and applied bacteria. Also, a humidity condition is important to the fermentation. Tastes and odors are different according to its fermentation period. Recently a two-stage fermentation method that uses two fermentation stages at 42~43°C and 50~53°C is used to remove a disgusting smells.

After completing the fermentation of cooked soybeans, some sticky and viscous materials are presented at the surface of soybeans and a unique smell is also generated.

4. Maturation

Fermented Cheonggukjang masses are to be roughly mashed and mixed with some salts and garlic according to needs and preferences. Then, finished products are matured and stored. The distribution of finished products is distributed under refrigeration. The taste of Cheonggukjang is not changed as it is frozen.

5. Quality characteristics of Cheonggukjang

Thermophilic bacteria are usually proliferated in Cheonggukjang according to the fermentation of soybeans at high temperature (higher than 40°C) in which *Bacillus sp.* is participated. These bacteria represent very particular and unique smells by dissolving soybean proteins. The smells are due to the trimethyl pyrazin and tetra methyl pyrazin newly generated from the fermentation with the 3-methyl-1-butanol in soybeans itself (Choi et al., 1989). It is considered that a large amount of free amino acids are generated in its fermentation process and that affects the taste of Cheonggukjang (Joo, 1971). In addition, soluble proteins are largely increased as much as 40~80kDa and differed from that of Natto (Santos et al., 2007).

The viscous substance that is a particular material in Cheonggukjang represents 61% of crude proteins. Also, the glutamic acid in amino acids shows the highest content, 32%, and a fibrinolytic activity is presented (Lee et al., 1991). In the fermentation process of Cheonggukjang, the viscous substance are different according to applied bacteria (Baek et al., 2008), and the molecular weight of the substance is about 15,000~65,000. The viscous substance usually consists of glutamate and fructose, and the composition of polymers is varied according to their proliferation conditions (Lee et al., 1992). In addition, there are some reports that the odors, compositions, and threshold values in Cheonggukjang are changed according to bacteria applied to the fermentation of Cheonggukjang (Kim et al., 2003; Seo et al., 1983).

3.4 Other fermented products

In addition to the fermented soybean products mentioned above, other various soybeans fermented products have been used in Korean dietary life. For instance, Doenjang dipping that are produced by mixing some Gochujang, garlic, ginger, hot pepper, and etc. to traditional Doenjang are taken with some wrapping vegetables including lettuces and cabbages. The Doenjang dipping are different types of improved and mixed Doenjang and enjoyed in Korea.

In addition, there are some soybean pastes, such as Eoyukjang made of dried beefs and fishes and Jeupjang made of Meju and dried vegetables. The Jeupjang show a fast fermentation process and can be taken as a side dish of boiled rice during summer season.

Such soybean fermented pastes produced by using various sub-materials based on Meju represent different tastes and preservations.

4. Functionalities of fermented soybean products

Various functional ingredients are already included in soybeans. In particular, a large amount of isoflavones (genistin, genestein, daidzin, and daidzein), which are a type of phytochemical, represent some functionalities in itself (Liu, 1997b). In addition, phenolic compounds (synergic, vanillic, chlorogenic, ferulic, and cinnamic acid), lignan, and carotenoids (lutein, and α - and β -carotene) including linoleic acid, linolenic acid, lecithin, choline, and saponin are included in soybean (Park, 2009). As these ingredients in soybeans represent their own particular physiological activities, the value of soybean is reevaluated by the people that have no concerns to take soybean as foods.

As mentioned above, there are many types of physiological active ingredients in soybean. In addition, according to some related studies on such issues, it has been known that fermented soybean products create new functional substances through various microbes.

This section proposes the summary of the functionalities of fermented soybean products in Korea, such as Doenjang, Gochujang, and Cheonggukjang.

4.1 Functionalities of Doenjang (Fermented soybean paste)

Doenjang are one of the traditional fermented soybean foods in Korea and produced with some other sub-materials including salts based on Meju produced by using soybeans as a principal material through its fermentation process. Meju represent its own physiological activities by generating new functional ingredients during its fermentation process in addition to the functional substances presented in soybeans.

The functionalities of Doenjang are deeply related to the isoflavones of soybeans, and anti-oxidant, anti-mutagenicity, and anti-cancer effects and ACE functions caused by fermented products have also been known.

4.1.1 Changes in the isoflavone content in Doenjang

It has been known that isoflavones are the glycoside of phenolic compounds and represent effects of preventing breast cancer and prostate diseases (Pagliacci, 1994; Severson, 1989). Also, various functionalities of soybeans presented in Korean Doenjang have been recognized (Kim, et al 1999). Based on this study, it can be seen that the ingredients of isoflavones are newly generated during the fermentation process of soybean (Table 5).

	Soybeans	Meju	Doenjang
Daidzein, free	106±7 ^{a1)}	269±38 ^b	578±70 ^d
Daidzein, total	406±29 ^a	433±41 ^{bc}	538±59 ^c
Daidzein, aglycones(%)	26.03±0.96 ^a	61.96±3.34 ^b	107.68±10.26 ^a
Genistein, free	95±20 ^a	137±16 ^b	455±10 ^d
Genistein, total	486±86 ^a	200±7 ^b	538±57 ^b
Genistein, aglycones(%)	19.49±1.1 ^{a3}	68.52±6.62 ^b	85.26±8.72 ^d
D/G ratio ²⁾	0.85±0.09 ^{ab}	2.16±0.17 ^c	1.00±0.10 ^b

¹⁾In each column, different alphabets in superscript show statistically significant difference(p<0.05)

²⁾Total daidzin contents/total genistein contents ratio

Table 5. Daidzein and genistein contents of soybean, Meju and Doenjang (mg/kg dry basis)

As shown in Table 5, the fermented Meju and Doenjang represent increases in the ingredients of isoflavones. In particular, the Doenjang show a high increase rate in these ingredients. In addition, the change of these ingredients to aglycone, which has a high absorption rate in the body, during its fermentation process by β-glucosidase is also presented (Kim et al., 1999).

The overall isoflavone contents in traditional and improved Doenjang are 370~723μg/g and 170~537μg/g, respectively, where the traditional Doenjang show higher level in the contents (Lee et al., 2010). The isoflavones of Doenjangs are presented as a type of aglycone.

4.1.2 Anti-oxidant effects

In general, anti-oxidant activities are related to anti-cancer and anti-mutagenicity characteristics. It is verified that lots of anti-oxidant substances exist in Doenjang. Doenjang extracts show an increase in oxidation delaying effects according to increases in the addition of the extracts as noted in Table 6 based on the results of the measurement of peroxide values by adding the extracts to linoleic mixtures (Cheigh et al., 1990).

Treatments	Peroxide value(meq/kg)	
Treatments	24 hrs	48 hrs
LA(Control)	790±55*	1113±40
LA+0.1%DP	707±64	1098±12
LA+0.2% DP	630±10	1056±60
LA+0.5% DP	393±28	1031±99

* Mean ± standard deviation

Table 6. Peroxide value of linoleic acid mixture(LA) with the addition of Doenjang powder(DP) during oxidation reaction at 50℃ for 24 and 48hrs.

Anti-oxidant effects in Meju and Doengjang show that it has relation to the amount of browning substances generated from phenolic compounds and its fermentation process (Lee et al., 1991).

In the results of the comparison of the anti-oxidant capabilities in browning chromatic substances, which are divided into fat and water soluble substances, significant anti-oxidant effects are presented and the structure of the primary amine is also verified (Kim, 1994^a). Also, a strong anti-oxidant activity is presented in water soluble browning substances in which the activity is varied according to its fermentation period (Lee et al., 1994). Peroxide values are largely decreased according to the fermentation period of Meju and Doengjang (Table 7) (Kim, 1994^b).

Sample	Days of storage	
sample	3	5
Control	230.4	770.1
Raw soybean	34.1	36.6
Meju(fermentation)		
30days	33.6	39.1
50days	32.4	38.3
80days	31.1	34.1
Doenjang(fermentation)		
0days	32.7	37.1
30days	23.9	32.0
60days	22.0	30.6

Table 7. Changes in peroxide values of linoleic acid after addition of isoflavone fraction at a 1% level (meq/kg)

In other studies, fermentation processes of Doenjang show increases in phenolic compounds and improve anti-oxidant capabilities in the comparison of peroxide values. Thus, it is concluded that the results are obtained by phenolic compounds and browning substances (Oh et al., 2007).

4.1.3 Lowering angiotensin converting enzyme (ACE)

The angiotensin II generated by ACE increases blood pressure and that makes possible to constrain hypertension by interrupting the effect. In the fraction obtained by dissolving Doenjang, the fractions that show ACE lowering effects of 90% and 70% and their structures are determined as arginin and proline as a type of dipeptide (Kim et al., 1999). In other studies, physiological activity peptides are separated from Doenjang and their activities are compared in which the histidine content in amino acids show the highest level (Shin et al., 1995). In addition, in the results of the comparison of the ACE lowering activity using methanol extracted from traditional Doenjang, the lowering effects are about 23.6~74.5% where the activity of α-glucosidase is also compared (Hwang et al., 2009). Also, in the results of the identification of the strains separated the microorganisms, which contribute to the fermentation of Doenjang, that show excellent ACE activities, the strains are verified as *Bacillus pumilus*. In other studies, by extracting *B. subtilis* SCB-3, which represents an effect of lowering ACE, the ACE lowering rate of the bacterium is 61% by applying it to the fermentation of Doenjang, and IC₅₀ shows a high value of 0.02mg/mL (Hwang et al., 1997).

4.1.4 Anti-cancer and anti-mutagenicity of Doenjang

In several studies on Doenjang, it has been known that Doenjang have anti-cancer and anti-tumer effects. Table 8 shows the results of the comparison of anti-cancer effects using SRB assays with respect to cancer cells through extracting the raw materials of Doenjang and methanol extracts (Lim et al., 1999).

Samples	OD510	Survival rate ⁵⁾ (%)	Inhibition rate(%)
Control	0.99±0.02 ^{a4)}		
Doenjang(SF)	0.45±0.01 ^d	45	55
SF(Soybean+flour) ¹⁾	0.64±0.03 ^b	65	35
Doenjang(S)	0.47±0.01 ^d	47	53
S(soybean) ²⁾	0.51±0.00 ^c	52	48
Miso ³⁾	0.54±0.02 ^c	55	45
Chongkukjang	0.51±0.01 ^c	52	48

Soybean : flour = 7:3, Soybean(100%), Light yellow Miso
Means with the different letters beside symbols are significantly different at the 0.01 level of significance as determined by Duncan's multiple range test.

Survival rate(%) =

OD510 of treated cells

OD510 of control cells

× 100

Table 8. Inhibitory effect of methanol extracts(2mg/ assay) of doenjang, other soybean products and soybean on the growth of AGS human gastric adenocarcinoma cells in sulforhodamine B(SRB) assay that determined after 2 days of incubation at 37℃

As presented in Table 8, Doenjang products represent higher anti-cancer effects than that of the raw materials of Doenjang. In the similar experiments of anti-cancer effects for liver and

large intestine cancer cells, Doenjang products show higher anti-cancer effects than other raw materials. (Lim et al., 2004).

In the results of the comparison of anti-cancer effects for liver and large intestine cancer cells using the Doenjang produced from Sunchang, which is a representative region of producing Korean traditional Doenjang, it shows higher lowering effects in the fractions of acetate and hexane more than 75% (Choi et al., 1999).

In addition, in the results of the studies (Hwang, 2007; Lee, 2009), it is considered that the peptides and other substances generated during the fermentation of Doenjang contribute to increase such anti-cancer effects.

Moreover, as the water used in producing Doenjang is replaced by germanium contained water or maple sap, it show high anti-mutagenicity effects. Also, nine times burned bamboo salts represent an increase in the effects (Lee et al., 2008). In the case of the Doenjangs produced by applying mushroom mycelium hyphaes, it shows higher anti-tumor and anti-cancer effects than that of traditional Doenjang (Lee et al., 2003).

4.1.5 Other functions

In traditional Doenjang, other various functions in addition to the above mentioned functions are verified by experiments. The excellent bacteria isolated from Doenjang are used to produce the Doenjang that can prevent thromboses and have high β -glucosidase contents (Ra et al., 2004). In addition, Doenjang show the lowering effects of hyaluronidase activities, which have anti-inflammation and anti-allergic effects, about 56~70% (Ahn et al., 2005). Also, Doenjang represent anti-bacterial effects for *B. cereus*, *E. coli*, *L. monocytognese*, and *S. aureus* (Yi et al., 1999).

4.2 Functionalities of Gochujang

Gochujang are a type of fermented seasoning by mixing some rice products dissolved by using hot pepper powders and barley malts based on Gochujang Meju. The functionality of this seasoning is deeply related to the ingredients of capsaicin and fermented products in red peppers.

In the classification of the studies on the functionalities of Gochujang, studies are focused on anti-obesity, anti-cancer, anti-tumor, and cardiovascular improvement effects. Also, some studies are focused on the anti-cancer effects on the basis of anti-oxidant effects.

4.2.1 Anti-obesity effects

The capsaicinoid included in Gochujang shows anti-obesity effects by promoting fat metabolism in the body. Based on the effects, a study on the anti-obesity effects using Gochujang is performed through animal and clinical tests (Park, 2009).

In the results (a 9.5% of the diet weight) of the measurement of anti-obesity effects in rats, which intake high fat diet, their weights and fat accumulation decrease as 13% and 30%, respectively (Fig. 11). The results show increases in energy consumption (Choo, 2000). In the results of the comparison of anti-obesity effects with that of hot pepper powders, the effects are caused by not only hot pepper powders but the fermentation of Gochujang (Fig. 12).

In the results of the comparison of the experiments performed by using various Gochujang, which show different production methods, for rats with high fat diet and Gochujang diet, the fermented rice Gochujang diet shows the highest effects of reducing fat tissues (Lee, 2002). Also, in the results of the comparison of the changes in weight for SD rats with high

fat diet and Gochujang diet in order to verify the differences before and after the fermentation of Gochujang, the rats with fermented Gochujang represent high weight-loss effects. In particular, the rats with traditional Gochujangs show large decreases in their weights. It shows that the fermentation process of Gochujangs increases weight-loss effects and decreases fats in epididymis and kidney (Lee et al., 2003). In similar studies, in the results of the animal tests by applying traditional and improved Gochujang and hot pepper

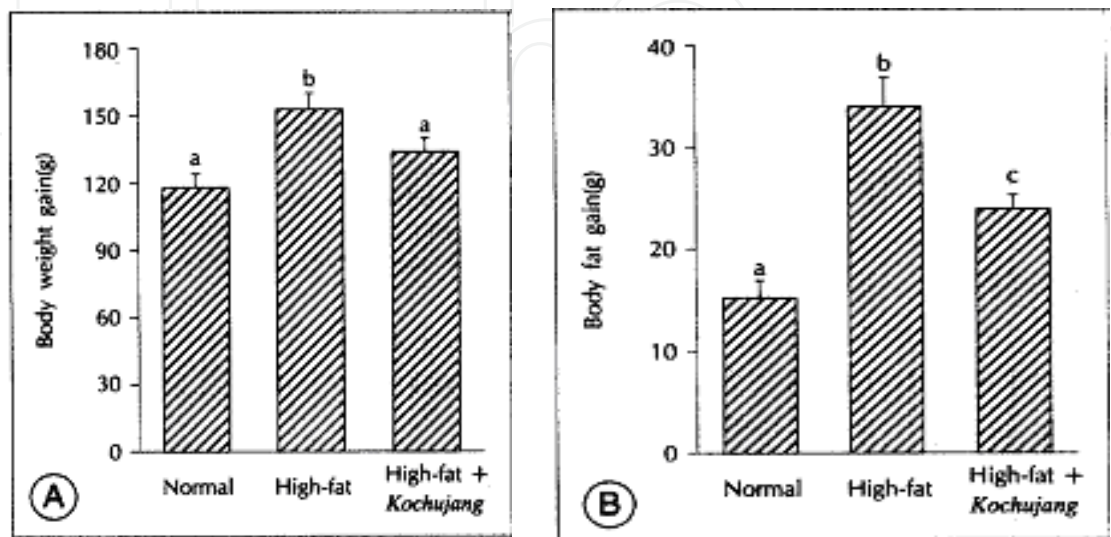


Fig. 11. Effect of Kochujang on body weight(A), body fat(B) in rats fed on a high-fat diet over 21days; normal diet(Normal), high-fat diet(High-fat). Values are means for eight rats, with their standard errors indicated by vertical bars. Bars not sharing a common letter were significantly different, $P<0.05$.

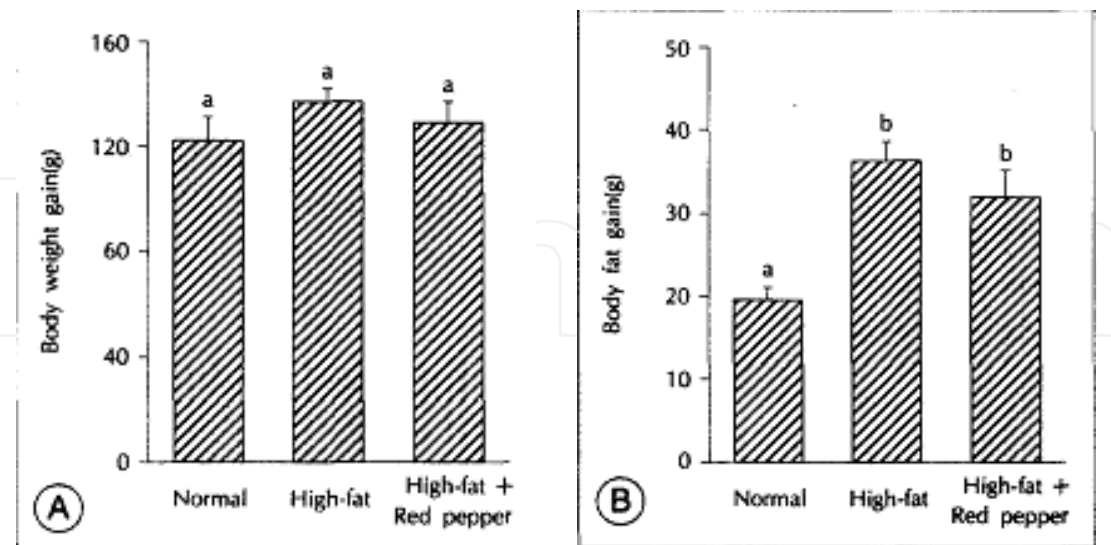


Fig 12. Effect of red pepper on body weight(A), and body fat(B) in rats fed on a high-fat diet over 21days; normal diet(Normal), high-fat diet(High-fat). Values are means for eight rats, with their standard errors indicated by vertical bars. Bars not sharing a common letter were significantly different, $P<0.05$.

powders, the fermented Gochujang represent significantly lower increases in their weights and improve the effects of its fermentation based on low intestine weights, low triglyceride contents, and low cholesterol contents (Kim, 2004).

The results of the actual clinical tests using Gochujang are presented (Kim, 2009). Gochujang are made as pills and applied to 54 subjects by 32g per day over 12 weeks. In the results, visceral areas and the ratio of visceral/subcutaneous fats are improved as a significant level. Also, the Gochujang intake group shows decreases in triglycerides and improves in serum lipids, fat proteins, atherogenic indexes, and coronary calcium indexes. Thus, it is estimated that the intake of Gochujang for a long period in obese people can prevent obesity and coronary diseases by improving serum lipids and fat proteins.

4.2.2 Anti-cancer and anti-tumor effects

The largest numbers of studies have been conducted are on the functionalities of Gochujang for anti-cancer and anti-tumor effects. In particular, there are many studies on the anti-cancer functions of Gochujang in which the results of positive effects are verified. In addition, traditional Gochujang products represent higher effects than other products (Park, 2002).

The substances for the anti-cancer effects are not determined as a single substance but a complex substance. In the results of the anti-cancer tests for the cells of stomach cancer using the samples extracted from methanol extracts, which are obtained by a freeze drying method from commercially distributed Gochujang with wheat koji, and other materials, the Gochujang fully fermented by using wheat koji represent the most excellent effects (Kim et al., 2005). For measuring anti-cancer and immune activities, onion added Gochujang are produced and processed using a freeze drying method in order to extract methanol extracts (Kim et al., 2005). The results show the effects of anti-mutagenicity as a concentration dependent way of *Salmonella typhimurium*, and onion added Gochujang represent higher effects than others. Also, in the case of MCF-7 cancer cell lines, the onion added Gochujang represent higher anti-cancer effects than others. The generation of NO in macrophages shows increases as a concentration dependent way and that also represents higher level than regular Gochujang.

In the results of the comparison of the weight of tumors since 32 days after transplanting Sacroma-180 tumor cells using the samples obtained from freeze dried traditional Sunchang Gochujang and factory made Gochujang by extracting them using methanol, the control group shows 6.0 g and the fermented traditional Gochujang shows 3.3 g. Thus, the traditional Gochujang represents an anti-tumor effect of 45%. However, unfermented Gochujang shows an anti-tumor effect of 17% only (Table 9). Although factory made Gochujang represents an anti-tumor effect of 23%, it represents lower effects than traditional Gochujang (Park et al., 2001).

Using the ethanol extracts of traditional Gochujang, the anti-mutagenicity characteristic is verified. Also, in Meju, it is verified that the extracts constrain the mutagenicity caused by aflatoxin B₁ (Kim et al., 1999). By obtaining the ethanol extracts of sea tangle powder added Gochujang, the tests of mutagenicity and cell toxicity are performed (Cui et al., 2002).

The results show that fermented Gochujang represent significant anti-cancer effects and increase such effects as the fermented Gochujang are mixed with other anti-cancer materials.

Sample	Tumor wt.(g)	Inhibition rate(%)
S-180+PBS	6.0±0.1 ^{a6)}	-
S-180+CK ²⁾	4.5±0.1 ^{bc}	23
S-180+TK I ³⁾	5.0±0.9 ^{ab}	17
S-180+TK II ⁴⁾	3.3±0.3 ^c	45
S-180+RPP ⁵⁾	4.7±0.3 ^b	22

Table 9. Antitumor activities of methanol extracts from various kinds of Gochujang and hot pepper powder(RPP) in tumor bearing Balb/c mouse with sarcoma-180 cell ¹⁾

1. 7-days sarcoma-180 ascites cells were s.c. transplanted into the left groin of inbredstran. 1.0 mg/kg of methanol extract from various kinds of Gochujang, red pepper powder or the equal volume of phosphate buffered saline (control) was i.p. injected once a day for 20 days from 24 hr following transplantation. All mice were sacrificed at 5 weeks following transplantation, and tumor, spleen and liver weight were measured.
2. Commercial Gochujang: Daesang Co.
3. Traditional Gochujang I: 0 day fermented Gochujang, Moonokrye Co.
4. Traditional Gochujang II : 6 month fermented Gochujang, Moonokrye Co.
5. RPP: the same as added in TK1 and TKII
6. Means with the different letters are significantly different (p<0.05) by Duncan’s multiple range test.

4.2.3 Other functions

In the case of the extracts of green teas or natural plants that are added to Gochujang, the extracts added Gochujang show increases in anti-oxidant capabilities and anti-bacterial effects (Kim et al., 2005). Also, garlic porridge added Gochujang show anti-oxidant and anti-cancer effects (Song et al., 2008).

In other experiments, as applying orotic acids, which have been known as a cause substance in accumulating triglycerides to the liver, the adding of capsaicin prevents the generation of such triglycerides and largely decreases the activity of phosphatidate phosphohydrolase, which contributes to the composition of triglycerides, and that leads to constrain triglycerides to the liver (Cha et al., 2004). Studies on the bacteria, which are separated from Gochujang, represent various functionalities in which the strains that produce a polymer of poly-γ-glutamate are *Bacillus* similar species. This substance has been largely used to control viscosity, to constrain bitter tastes, and to produce various medicines and show a possibility of economic mass productions (Kang et al., 2005). In addition, by isolating the bacteria that have the effects of thromboses dissolution, immunity activation, and cell toxicity from Gochujang, the possibility of the bacteria contributed to the fermentation of Gochujang is considered as a different way through identifying it into *Bacillus stearothermophilus* and *B. amyloliquefacience* (Seo et al., 2007).

4.3 Functionalities of Cheonggukjang

Cheonggukjang are a pure soybean fermented product that can be used in the table within a short period of time after fermenting cooked soybeans at high temperature and require a small amount of salts and seasonings as in the table. Cheonggukjang have a particular viscous substance and represent a unique small. Also, it shows specific functionalities due to the substances created during its fermentation including the functionalities of isoflavones presented in soybeans itself.

Effects of preventing hypertension, improving fat metabolism, thromboses dissolution, anti-oxidant, and preventing osteoporosis including physiological effects have been known (Kim et al., 1999; Lee et al., 2005).

4.3.1 Anti-cancer effects of Cheonggukjang

In the results of the tests of the lowering effects for cancer cells using the Cheonggukjang methanol extracts, the lowering rate is 65% and that is a higher level than that of Miso. Also, it shows the lowering effects for liver cancer cells in which the lowering rate is 60% (Lim et al., 2004). In addition, it shows an effect of constraining other cancer cells (Lim et al., 1999). In particular, by adding the porphyrin extracted from lavers to Cheonggukjang, the porphyrin added Cheonggukjang represent high constraint effects for cancer cells such as bowel cancer (Min et al., 2008). The results represent that although regular Cheonggukjang show the constraint effects of proliferation as 19~27%, the porphyrin added Cheonggukjang represent increases in the constraint effects of proliferation about 27~32%. Thus, it is verified that Cheonggukjang show significant constraint effects on cancer cells.

4.3.2 Lowering Angiotensin converting enzyme (ACE)

Studies on the constraint of blood pressure increases by lowering ACE activities are performed. Cheonggukjang show specific ACE lowering effects (Kil et al., 1998) and peptides are known as its cause factor (Cho et al., 2000). The peptide contents are the order of alanine (30.84%), phenylalanine (30.3%), and histidine (20.24%). In the results of the calculation of the lowering rate of ACE, a 1mg of peptides represents 74.74%. Although traditional Cheonggukjang use straws as a starter (Kim et al., 1982), some superior bacteria are separated from Cheonggukjang and used to the fermentation of Cheonggukjang in order to manage the fermentation (Kil et al., 1998; Hwang, 2010). In these results, the fibrinolytic activity generated by such superior bacteria represents a high level (Table 10). Also, it is verified that the threshold value of enzyme shows increases as Meju are only used as a matrix. In addition, although the microorganisms that contribute to the fermentation of Cheonggukjang are usually *Bacillus sp.*, some strains that strongly secrete fibrinolytic enzymes employed in the *Bacillus sp.* (Kim et al., 1995).

Temperature (°C)	Strain	Fibrinolytic activity (cm)		
		Fermentation time (hr)		
		24	48	72
40	CJJN-4	2.30±0.31	2.50±0.24	2.40±0.45
	CJJN-5	2.20±0.18	2.30±0.37	2.30±0.26
45	CJJN-4	1.40±0.37	1.50±0.44	1.80±0.12
	CJJN-5	2.10±0.25	2.00±0.27	1.90±0.38

Values are mean±SD.

Table 10. Comparison of fibrinolytic activities of Cheonggukjang fermented with CJJN-4 or CJJN-5 on fermentation temperature

4.3.3 Other functions

In the results of the animal tests, white rats, by inoculating the extracted superior bacteria with respect to high cholesterol and Cheonggukjang intake groups, the effects that constrain

the generation of peroxide fats in liver tissues and protects liver damages are verified (Kim et al., 2009). Regarding other effects, it removes sodium nitrides including anti-oxidant effects and verifies the effects on the constraint of inflammations (Ahn et al., 2005). In addition, the application of Cheonggukjang effectively constrains increases in blood pressures from animal tests (Yang et al., 2003). Also, the sticky viscous substance shows decreases in blood sugars and serum lipids (Kim et al., 2008).

5. Conclusion

The origin of soybeans has been known as Manchuria, Far East Asia. Then, soybeans were propagated to various countries of the world. In some Southeast Asian countries, in particular Korea, China, and Japan, soybeans have been variously used in their dietary life and contributed to improve nutrients as protein sources. The history of using soybeans goes back to B.C. On the other hand, in Western countries, soybeans have been largely used as feeds and oil source. However, recently these countries also use soybeans as food materials and produce various soybean processing products.

Soybeans are an important position in Korean dietary life as one of the five major grains and have been taken by soybeans itself with boiled rice. Also, soybeans have been variously used by processing it or by growing it as vegetables. Then, soybeans have been taken as vegetables, powders, and other various types of foods differed from other countries. In particular, fermentation methods using molds, bacteria, and yeasts are developed using cooked soybeans and that leads to produce Ganjang (soybean sauces), Doenjang (fermented soybean pastes), Cheonggukjang, and Gochujang (fermented hot pepper soybean paste). These products have been used in Korean dietary life as the primary seasonings and side dishes. Also, these soybean products play important roles in differentiating Korean foods from other foods.

Recently phytochemicals including isoflavones in soybeans have been known as functional ingredients. Also, it is verified that soybean proteins have physiological activities from the results of various studies. Therefore, people around the world represent interests on the use of soybeans as foods. In addition, lots of soybean processing products have been produced and distributed due to their effects on preventing various chronic diseases through simple pharmacological treatments only.

In Korea, regarding the characteristics of using soybeans, various soybean products have been developed using specific fermentation processes. It has been scientifically proven that various functionalities are newly created during several fermentation processes. Also, studies on this issue have been continuously conducted. In the specific functionalities of soybean products, it contributes to present effects on anti-cancer, anti-tumor, improving blood circulation, and preventing chronic diseases. In the case of Gochujang, it has been known that Gochujangs represent significant effects on constraining obesities.

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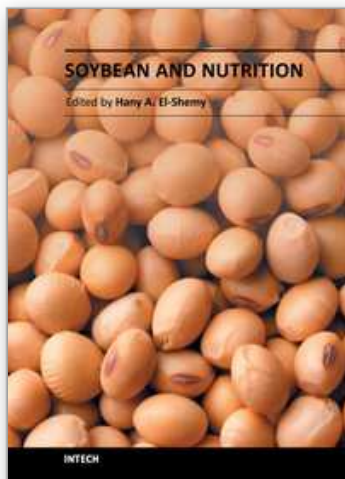
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Soybean and Nutrition

Edited by Prof. Hany El-Shemy

ISBN 978-953-307-536-5

Hard cover, 476 pages

Publisher InTech

Published online 12, September, 2011

Published in print edition September, 2011

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How to reference

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Dong Hwa Shin (2011). Utilization of Soybean as Food Stuffs in Korea, Soybean and Nutrition, Prof. Hany El-Shemy (Ed.), ISBN: 978-953-307-536-5, InTech, Available from: <http://www.intechopen.com/books/soybean-and-nutrition/utilization-of-soybean-as-food-stuffs-in-korea>

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