Kor. J. Appl. Microbiol. Bioeng.
Vol. 9, No. 4, 253—261 (1981)

Traditional Fermented Food Products in Korea

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(Received November 12, 1981)

韓国의 醱酵食品에 関하여

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(1981년 11월 12일 수리)

Abstract

Fermented foods available in Korea may be classified into four groups, namely, fermented soybean products, fermented cereal products, fermented vegetable products, and fermented fishery products based on raw materials used.

The representative fermented foods based on soybean are Kanjang(soysauce), Doenjang(fermented soybean pastes), and Kochujang(red pepper added-fermented soybean paste). Such fermented products are made using Meju(functioning as a starter and prepared by fermentation of steamed soybean mash) as an essential ingredient, and used widely as a soup base and/or in seasoning side-dishes for everyday meals year around.

Excepting Sikhae, all fermented products based on rice and other cereal grains are of alcoholic nature. Takju (Makgeolli) used to be made using rice as the major raw material, however, mainly due to the shortage of rice in recent years, other cereals, such as, barely, corn, and wheat flours are also used to replace rice today. Owing to such changes in the raw materials, the popularity of Takju has been somewhat reduced, yet it is still widely consumed in rural areas. Although Chungju is a popular rice wine with superior quality over Takju, the amount consumed is considerably limited. The highest quality rice wine, Bupju, in particular, is made by a low temperature fermentation using glutinous rice.

Kimchi is an unique fermented vegetable product of long tradition in Korea. Although it was for consumption mainly in winter season serving as a source of vitamins, today it is widely used throughout the year. Except Kkakdugi and Dongchimi, all of the fermented vegetable products contain salted Korean cabbage as an essential item, while they abound in varieties depending on material composition and methods of processing, and also on seasons and localities. Next to Kimchi in this category is Kkakdugi made of raddish in popularity and quantity consumed.

*This paper was presented to the 8th ASCA conference, Medan, Indonesia, Feb. 9, 1981.

The four groups of fermented food products described above are reviewed in some detail and evaluated in terms of their nutritional significances, processes and microorganisms involved, and their commercial potentials.

Jeotkal (or Jeot) is a name given to all fermented products of fishery origin. A number of Jeot can be prepared by adding salt and allowing fermentation to the raw materials such as shrimp, anchovy, octopus, clam, oyster, etc.

I. Introduction

The fermented foods have played an important role in Korea dietary life in which they constituted the basis of the taste of Korean traditional meals and contributed significantly to the nutrition of Korean people. The factors which have made the fermented foods so important in Korea are considered to be the geographical and climatic conditions, and the food habit of the people. Firstly, the temperature climate of Korea provides an excellent condition for the long-term natural fermentation at various temperatures. That is, the initial low temperature fermentation in the winter followed by the warm temperature ripening in the spring, or vice versa through autumn to winter is essential for the formation of the characteristic taste of some Korean traditional fermented foods. Secondly, the cereal preponderance of the people requires salty and meaty taste of sidedishes all year round. From the prehistoric ancient time the fermented foods in Korea have been developed to meet such requirements. Except for the alcoholic beverage making, the fermented products are made with the salted raw materials. It gives the salty taste to the diet and also allows us to preserve the food materials. Consequently, however, the fermented foods have served as the important nutritional supplements to the cereal diets and still they are.

In this respect, this paper deals with the present status of the traditional fermented foods in Korea and the problems associated with industrialization of such food products to meet the requirements of modern life of today. In doing so, for the convienience, a classification is made on the basis of the major ingredient used; namely; fermented soybean products, fermented cereal products, fermented vegetable products and fermented fishery products. Of all of the traditional fermented foods available, only several representative items of today from each categories of the above classifications will be discussed in some detail.

II. Fermented Soybean Products

According to the old literatures available today, the history of soybean cultivated for food uses in the Orient is estimated dating back to 4,000-5,000 years in China, 2,000 years in Korea and 1,000 years in Japan.[1,2] Certainly, fermented soybean products may have constituted an important type of food products using soybean as the raw materials from around those days. Since then the types of fermented soybean products have been diversified widely with the time and the localities. At present, the representative fermented food products based on soybean are Kanjang (soysauce or soybean sauce), Doenjang (fermented soybean paste), and Kochujang (red pepper added-fermented soybean paste).

The typical fermentation processes for such traditional food products are characterized by the use of Meju as a starter for the fermentation. Meju is a solid matter in a form of rectangular block with its weight of around 1Kg each, and is made in autumn by allowing fermentation of steamed soybean mash on which natural molds are grown on the surface and bacteria are inhabited inside during drying process in air. The typical microorganisms found in Meju are *Aspergillus oryzae*, *Aspergillus sojae* and *Bacillus subtilis*.[1] Traditionally, home-made soybean sauce and soybean paste are obtainable simultaneously from the Meju-brine mixtures after allowing further fermentation and ripening processes for several months in earthern jars. The supernatant dark brown liquid of the mixtures is soybean sauce and the brownish solid residue is soybean paste. Today, however, both products commercially available in the markets are manufactured separately by industrial firms and soybean sauce and soybean paste obtainable from such separate procedures are similar to corresponding Japanese products. In 1979, 388,684Kl of soybean sauce were produced and the amounts of soybean paste produced were 268,757M/T and of the total 1/4 of soybean sauce and 1/5 of soybean paste were commercially manufactured. Perhaps, one of

the reasons for the limited industrialization is the differences in the taste between the home-made and industrial products. The commercial products are milder in the taste compared to the home-made products, and people prefer the sharp and somewhat delicate flavor of the traditional products.

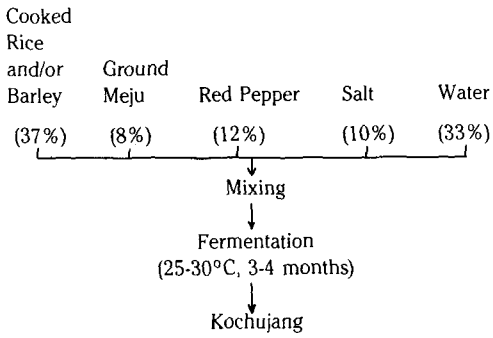

Fig. 1. Flow Sheet of Kochujang Making Process.

Kochujang, red pepper-added fermented soybean paste with the appearance similar to tomato ketchup, is the unique food product only available in Korea reflecting the hot spice preference of the people. It is prepared by mixing ground Meju powder with steamed cereal flour (mainly rice with or without wheat flour), red pepper powder, malt powder, salt and water, and allowing further fermentation and ripening of the mixture in earthen jars for several months as shown in Fig. 1. Fig. 2 shows the changes of some fermentation parameters during the process of Kochujang making at 25°C. The activities of saccharogenic amylase and acid protease were increased rapidly at initial stage of fermentation and reached their maximum level after 30 and 50 days, respectively, and then decreased sharply to reach the minimum level after 90 days. However, amino nitrogen, one of the major taste component of the product, was increased gradually until 90 days along with the progress of fermentation, and slowly reached the maximum plateau (247mg %) thereafter.[3] These changes shows that the fermentation phase was almost completed in about 90 days at 25°C and 10% salt concentration and followed by its ripening phase. The ripening phase requires at least one month in order to obtain an acceptable product for marketing. The estimated amount of Kochujang produced reached 130,195M/T in 1979, of which 1/4 commercially produced.

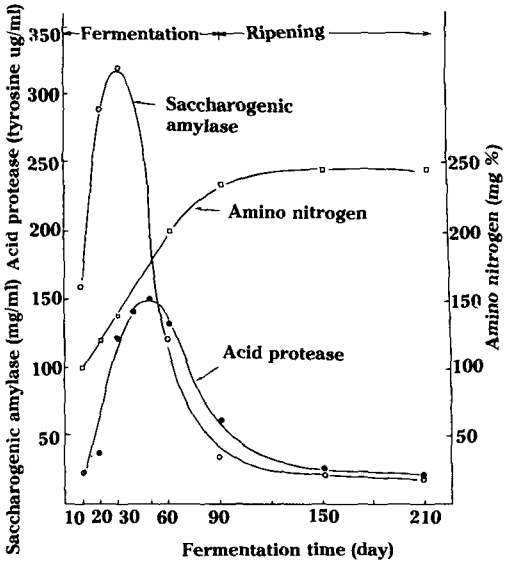

Fig. 2. Changes in Enzyme Activity and Amino Nitrogen during Kochujang Fermentation at 25°C.

One of the recent developments in this area is the industrial production of Meju by inoculating *Aspergillus oryzae* for use in individual households. This allows housewives to save their time and labor, with no need for extra space at home. The products made using industrially produced Meju are found acceptable to the people and superior in the protein quality to that of traditionally prepared products.[4]

Table 1. Chemical Composition of Fermented Soybean Foods in 100g Edible Portion.

	Kanjang	Doenjang	Kochujang
Calories (Cal.)	38	128	171
Water (%)	71.17	51.0	47.7
Protein (g)	4.3	12.0	8.9
Fat (g)	0.4	4.1	4.1
Carbohydrate (g)	4.4	10.7	25.9
Ca (mg)	62	122	126
P (mg)	38	141	72
Thiamine (mg)	0.03	0.04	0.35
Riboflavin (mg)	0.01	0.20	0.35
Niacin (mg)	1.2	0	1.50
Ascorbic acid (mg)	0	0	(10)*
B-Carotene (ug)	0	0	210

* 5% red pepper powder.

Chemical compositions of the above mentioned three products are illustrated in Table 1[5] and clearly indicate that they are rich in protein and minerals. Such fermented soybean products are used widely as a soup base and/or in seasoning a number of sidedishes to be served for everyday meals year round. It is interesting to notice that there are practically no changes in the amounts of such products produced in recent years, and it may be attributable to the increased availabilities of other processed foods.

III. Fermented Cereal Products

Excepting Sikhae, all fermented products based on rice and other cereal grains are of alcoholic nature. The alcoholic fermentation technologies have been evolved for thousands of years with the history of Korea. The long history of alcoholic fermentation is also evidenced by the fact that the related technology of alcohol fermentation using Nuruk was transferred to Japan as early as in 3rd century from Korea. Although numerous kinds of alcoholic beverages can be found in the old literatures, today four representative traditional products, namely, Takju (or Mekgeolli), Yakju, Chungju and Bupju are most popular.

The typical process in traditional cereal fermentation is also characterized by the use of Nuruk as a fermentation starter in which its role is similar to that of Meju for soybean fermentation. Nuruk is a dry matter of flat and round shape in somewhat concave manner of around 1Kg per lump and is made by allowing fermentation of the moulded mixture of steamed crushed wheat. The concave shape of Nuruk is appearently important for the uniform growth of the useful microorganisms. The characteristic flavor of the traditional wines especially Yakju, is partially imported by the selected covering materials, such as, rice straw, mugwort, or pine needless during the drying period of Nuruk.[6] Today, such alcoholic fermentation in Korea is carried out by the licenced wine breweries under the control of the government authorities concerned. In such modern breweries the use of Nuruk is largely replaced by the pure culture of *Aspergillus oryzae* on cereal grains.

Takju was used to be made using rice as the major raw material, however, mainly due to the shortage of rice in recent years, other substitute cereals, such as, barely, corn, and wheat flours are also used to replace rice today. Cooked cereals are mixed with crushed Nuruk and added enough water and then allow them to ferment in earthen jars at warmer place for several days. When the alcoholic fermentation is completed, Yakju, the clear supernatant of the fermented broth, is obtained with its alcohol content of 10-12%, and the remaining turbid liquid is further diluted with water to adjust its alcohol content to 5-7% to produce Takju. Owing to the above mentioned changes in the raw materials, the quality of Takju and Yakju are consequently altered and thus the popularity of the wines have been somewhat reduced. Takju is cheap and nutritious than other alcoholic beverages and is still widely consumed in rural areas. Although Chungju with its alcoholic content of 16% is a popular rice wine with superior quality over Takju, the amount consumed is considerably limited. Chungju is manufactured by modern breweries by use of selected pure culture as a fermentation starter and the resulting clear wine is similar in its nature to that of Japanese rice wine (sake). Many of the specialty alcoholic beverages with long tradition are disappearing and forgotten by the people in recent years. Notwithstanding such unfortunate situation, however, some successful cases are emerging. One novel example is the industrial production of Bupju having the literary meaning of temple wine. Bupju is the highest quality of local rice wine with alcohol content of 16% available again today and is made by a low temperature fermentation process using rice and glutinous rice mixture as illustrated in Fig. 3.[7] The taste of Bupju served in cold is gaining popularity and is also widely appreciated by the tourists visiting Korea. In

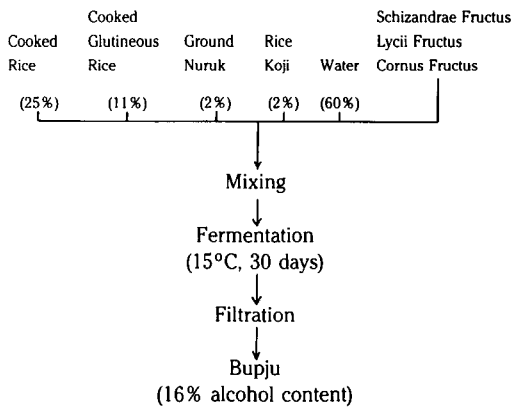

Fig. 3. Flow Sheet of Bupju Making Process.

1979, the combined amount of Takju and Yakju was 1,348,111Kl, of which only 0.4% accounted for Yakju, and Chungju amounted to 30,752Kl.

One of the technological problem in Takju making is the short shelf-life of the product. This beverage containing 5-7% alcohol is liable to get sour in 1-2 days at the room temperature after completion of the fermentation. This acidification not only deteriorates the taste but also reduced its energy content.[8] Development of the proper preservation method of this beverage without changing the characteristic flavor and taste is required.

The only existing non-alcoholic fermented cereal products is Sikhae. It is a sweet and somewhat sour beverage and is made by mixing cooked rice and ground malt in water and then keeping the mixture for a few days in warm place. This process often utilizes, the left-over cooked rice which became already unpalatable. The industrial production of Sikhae, however, is yet to attempted at in Korea.

IV. Vegetable Fermented Foods

Kimchi is the name given to a group of fermented vegetable foods of long tradition in Korea. It has been a main sidedish served along with cooked rice and other dishes. The kinds of Kimchi may count up to 64 depending on the use of raw materials and processing methods, and also on the seasons and localties of preparations. Baechu-Kimchi and Bossam-Kimchi based on Korean cabbages and Kkakdugi, Dongchimi, and Chonggak-Kimchi based on Korean radish are the most popular items during winter season. On the other hand, Yeolmu-Kimchi based on radish and Oisobaegi and Oiji based on cucumber are popular in summer season. Of all of such fermented vegetable products, Baechu-Kimchi is the most important one in terms of its quantity consumed, taste and nutritional significances to the people, and very often referred to simply as Kimchi.

The Kimchi making is the original Korean method of preserving the fresh and crispy texture of vegetables during the winter when fresh vegetables are not generally available. Kimchi has an unique sour, somewhat sweet and carbonated taste and usually served cold. In this respect Kimchi differs from Sauerkraut which is only acidic in taste and served in warm state.

Raw materials for Kimchi are mainly divided into 3 groups. Korean cabbage and radish are the major materials and minor ingredients include garlic, red pepper, green onion, ginger and salt, and lastly fermented fishery products and other seasoning agents are often

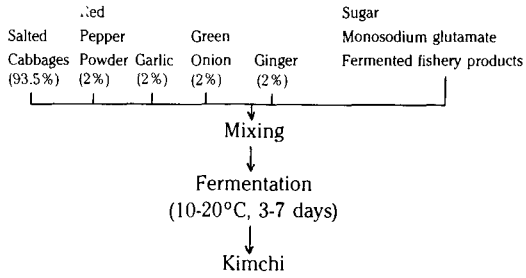

Fig. 4. Flow Sheet of Kimchi Making Process.

used as the optional ingredients. A recipe for the simplest Kimchi may include Korean cabbage 100g, garlic 2g, green onion 2g, red pepper powder 2g, ginger 0.5g with optimum salt content of 3.0%.

Fig. 4 shows the procedure for such Kimchi preparation. Whole cabbages (or cutted) are salted with 15% brine for 3-7 hours, which are then washed twice with fresh water and drained. Other minor ingredients, chopped and combined, are mixed to the treated cabbages and placed in the containers tightly sealed. Lastly, a proper fermentation will ensure to make an acceptable Kimchi. The length of time for completion of the fermentation depends on the salt content and temperature. The majority of Kimchi are still prepared at household level even today and only a limited amounts are commercially produced in a can or in bulk. Annual production of canned Kimchi amounted to 500,000 cans for 1979 which is about 3% of the total commercial output of Kimchi. Although statistical data on the production of home-made Kimchi are not available, the amount of cabbages and radishes used for Kimchi was estimated at about 1 million tons in 1979.

Fig. 5 shows the changes in reducing sugar, total acid and pH during the fermentation of Kimchi. The optimum pH and acidity for the best taste is 4.2 and 0.6% (as lactic acid), respectively. It shows that the best taste is attained after 3 days of fermentation at 20°C and 3% Nacl.[9,10] Under a similar conditions, fermentation for Sauerkraut usually takes 20-30 days. Fig. 6 shows the changes in the

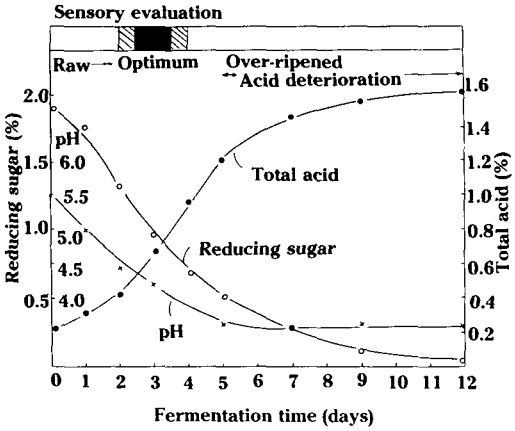

Fig. 5. Changes in Reducing Sugar, Total Acid and pH during Kimchi Fermentation at 20°C (3% NaCl).

microflora during Kimchi fermentation at 14°C and in 3.5% salt content.[9] The number of *Leuconostoc mesenteroides* increased after 10 days of the fermentation. The numbers of lactic acid forming bacteria and yeasts started to increase after 10 days of the fermentation, and this accompained with the overripening and souring of Kimchi. It indicates that *Leuconostoc mesenteroides* is the important microorganism responsible for Kimchi fermentation, whereas *Lactobacillus plantarum*, which is considered to be responsible for the Sauerkraut making, deteriorates the quality of Kimchi. It is also worthy to note that there are considerable increase in B vitamines during fermentation. That is, the contents

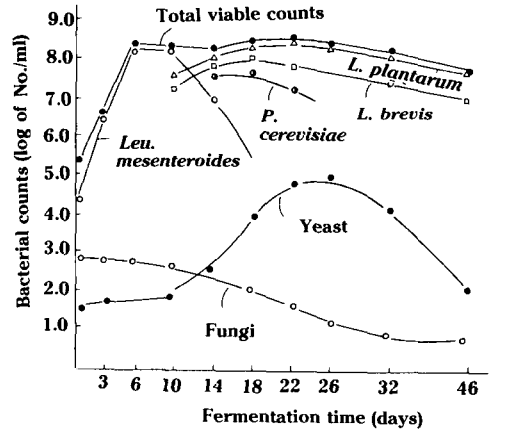

Fig. 6. Changes in Microflora during Kimchi Fermentation at 14°C (3.5% NaCl).

of B_1, B_2, B_{12} and niacin may reach as high as twice of initial contents at the optimal maturation of Kimchi and then decrease as the taste of Kimchi deteriorate due to the over fermentation.[11]

Table 2. Chemical Composition of Fermented Vegetables in 100g Edible Portion.

	Baechu-Kimchi	Kkakdugi	Dongchimi
Calories (Cal.)	19	31	9
Water (%)	88.4	87.0	93.6
Protein (g)	2.0	2.7	0.7
Fat (g)	0.6	0.8	0.2
Carbohydrate (g)	1.3	3.2	1.1
Ca (mg)	28	5	1
Thiamine (mg)	0.03	0.03	0 0.01
Riboflavin (mg)	0.06	0.06	0.03
Niacin (mg)	2.1	5.8	1.0
Ascorbic acid (mg)	12	10	7
B-carotene (μg)	295	568	0

Table 2 shows chemical compositions of some fermented vegetable products and clearly indicates that such products are somewhat rich in B vitamins and thus serves as a good vitamin source to the people during winter in particular.[5] According to a recent nutrition survey, an adult consumes 50-100g/day of Kimchi in summer and 150-200g/day in winter.[12] These figures indicate considerable decrease as compared with earlier years and tend to decrease further in line with the increased availability of other foods. Furthermore, the changes in life style and rapid urbanization households no longer convenient. In addition, there are also growing export markets, and thus the expansion of industrial production of Kimchi is considered inevitable. The major obstacle for the mass production, however, is the inherent short shelf-life of Kimchi after completion of the fermentation. Although a number of attempts have been made to preserve Kimchi in the past, there is not a single procedure yet to ensure satisfactory product. So far preservation of Kimchi under refrigeration of around 5°C is known to be a best way for a longer preservation ranging up to 5 months, while canning of Kimchi, though good for preservation, usually brings softening of texture and some off flavors.

V. Fermented Fishery Products

The long costal line of the Korean peninsular provides a variety of marine products for human consumption. Of which, however, small shrimp, anchovy, oyster, clam, octopus and others are the important raw materials for fermented fishery products. Such fermented products are called collectively as Jeotkal or Jeot in Korean and each specific name of Jeotkal is based on the raw material used, such as, Saewoo-Jeot for fermented shrimp, Kool-Jeot for fermented oyster and so on. About 30 kinds of Jeotkal are found in the market presently, and each Jeotkal has a certain specific taste and flavor derived from both enzymatic and microbial degradation of raw materials used. Jeotkal is made by salting fish or shellfish, after slicing if necessary, and allowing fermentation and ripening for 2-5 months depending on the raw material, salt content, temperature, and container used.

Yearly production of Jeotkals in total amounted to 5,334M/T for 1979, and the majority of such products are produced by small scale manufacturers in the fishery towns. An important benefit of fishery fermentation is that the most of fishery wastes, such as, viscera, heads and eggs can also be utilized in making Jeotkals. Although fermented shrimp, oyster and anchovy are frequently used as an important ingredient for Kimchi making, the majority of Jeotkals are also independently consumed as a delicacy sidedishes along with cooked rice, and some items are quite expensive due to the limited supply.

Table 3. Chemical Composition of Fermented Fishery Products in 100g Edible Portion.

	Anchovy	Shrimp	Clam	Oyster
Calories (Cal.)	165	47	106	106
Water (%)	60.3	64.9	67.5	70.8
Protein (g)	13.3	10.5	14.5	15.9
Fat (g)	11.4	0.6	4.3	3.6
Carbohydrate (g)	2.3	—	2.3	2.4
Ca (mg)	330	681	378	491
P (mg)	409	287	366	211
Thiamine (mg)	0.01	0.05	0.05	0.06
Riboflavin (mg)	0.22	0.04	0.0 9	0.0 5
Niacin (mg)	—	—	—	1.0
Ashcorbic acid (mg)	0	0	0	0
B-carotene (μg)	—	0	5	12

Chemical composition of such fermented products are shown in Table 3.[5] Although such products are relatively high in calories, protein and especially in some minerals. Their nutritional significance is rather minor as the per capita intakes are somewhat limited due to the high salt content.

VI. Conclusion

Four groups of fermented foods described above are

Table 4. Estimated Minimum Daily Nutrients Supply per Person from the Fermented Food Products (1979)

Items	Amount of supply (g)	Energy (Cal.)	Protein (g)	Fat (g)	Ca (mg)	Vitamins B_2 (mg)	niacin (mg)	C (mg)
Total foods	1,141	2,533	73.8	33.1	483.9	0.91	23.76	107.76
Soybean products	57.1	52.2	4.4	0.9	40.8	0.05	0.48	0.94
(%)	(5.0)	(2.1)	(6.0)	(2.7)	(8.4)	(5.5)	(2.0)	(0.9)
Vegetable products	100.0	19.0	2.0	0.6	28.0	0.06	2.10	12.00
(%)	(8.8)	(0.8)	(2.7)	(1.8)	(5.8)	(6.6)	(8.8)	(11.1
Fishery products	0.6	0.99	0.08	0.07	1.98	0	0	0
(%)	(0.05)	(0.04)	(0.11)	(0.21)	(0.41)			
Total fermented products	157.7	72.2	6.5	1.6	70.8	0.11	2.58	12.94
(%)	(13.8)	(2.9)	(8.8)	(4.8)	(14.6)	(12.1)	(10.9)	(12.0)

Table 5. Process Parameters of Fermented Food Products in Korea

Fermented products	Substrates		Fermentation conditions			Commercial status
	Items	Heat treatment	Temperature (°C)	Period (days)	Key microorganisms	
Soybean products						
Kangjang	Soybean Salt (22%)	Yes	25-30°C	180	*Asp. oryzae*, *Asp. sojae* *Sac. rouxii*	25%
Doenjang	Soybean Salt (8-12%)	Yes	25-20°C	90-120	"	20%
Kochujang	Soybean, Rice, Red pepper Salt (10%)		25-30°C	90-120	"	25%
Cereal product						
Takju	Rice (or Wheat)	Yes	15-20°C	7-30	*Asp. Oryzae* *Sac. cerevisiae*	100%
Vegetable						
Kimchi	Cabbages, Garlic, Red pepper Green onion, Salt (3%)	No	10-20°C	3-15	*Leuc. mesenteroides*	1%
Fishery product						
Jeotkal	Fishes (or Shellfishes) Salt (20-25%)	No	20°C	90-120	Miscellaneous	90%

briefly summarized in Table 4 for the estimated nutritional contribution to Korean diet, and in Table 5 on the process parameters and industrial status. The cereal fermented products are eliminated from the nutritional considerations since same mainly supply calories in the form of alcohol and are consumed only by adult male population. Then, the estimated per capita daily consumption of fermented foods calculated from the food balance sheet of 1978[13] ranged from 0.6g to 100g by kind and totalled to 157.7g as a whole, and thus constituted 13.8% of total daily food supply. It is very important to note that 8.8% of total protein was supplied by such fermented products. Furthermore, it should not be overlooked that such foods also played an important role as mineral and vitamin sources to the Korean diet.

The length of fermentation period for each product varies depending on the temperature and salt concentration as shown in Table 5. Mostly, fermentation is carried out at ambient temperature for the household level production. However, in the case of industrial production of fermented foods, the temperature of each product is maintained at respective optimum levels, that is, 25-30°C for soybean products, 15-20°C for cereal products, 10-20°C for vegetables, and 20°C for fishery products. *Aspergillus oryzae*, *Aspergillus sojae*, and *Saccharomyces rouxii* are known to be mostly responsible for soybean fermentation, and the major microorganism responsible for Kimchi fermentation is *Leuconostoc mesenteroides*. For alcoholic fermentation using cereals, *Aspergillus oryzae* and *Saccharomyces cerevisiae* play an important role. Many microorganisms were also isolated and identified from various fermented fishery products, but no specific species in this category are found yet. The degree of industrialization of the traditional fermented foods varied depending on the products as seen in Table 5. Approximately 20-25% of the total production of soybean products are produced commercially, while only less than 1% of Kimchi is processed by commercial manufacturers. On the other hand, almost all of the cereal and fishery fermented products are commercially processed today. The industrial potentials of these products are high along with the changes in living conditions, and the innovative R & D efforts will certainly expand the potentials further in the near future.

References

1) KIST(Ed.) : Comprehensive review of the literatures on Korean foods, Korean Society of Food Science and Technology, Seoul, Korea, (1970)
2) Watanabe, T.J. *et al.* : Soybean Food, Tokyo, Japan, (1971)
3) Lee, T.S. : *J. Korean Agr. Chem. Soc.*, **22**, 65 (1979)
4) Lee, C.H. : *Korean J. Food Sci. Technol.*, **8**, 19, (1976)
5) Office of Rural Development : Food composition table, Suwon, Korea, (1977)
6) Lee, C.Y. and C.H. Chang : *Report of Tech. Res. Inst. of Tax Office*, **2**, 77, (1969)
7) Kim, D.C. and B.I. Ser : *Report of Tech. Res. Inst. of Tax Office*, **3**, 46, (1975)
8) Hong, S.W., Y.C. Hah and B.J. Lim : *Report of Brewing Lab. of National Tax. Office*, **1**, 18, (1968)
9) Mheen, T.I. and T.W. Kwon : Proceedings of the International Symposium on Microbiological Aspects of Food Storage, Processing and Fermentation in Tropical Asia, Bogor, Indonesia, Dec. 10-13, (1979)
10) Lee, Y.H. and I.W. Yang : *J. Korean Agr. Chem. Soc.*, **13**, 207, (1970)
11) Lee, T.Y., J.S. Kim, D.H. Chung and H.S. Kim : *Bull. Sci. Res. Inst. (Korea)*, **5**, 43, (1960)
12) Choo, S.Y. : *Korean J. Public Health*, **10**, 145, (1973)
13) Ministry of Agriculture and Fisheries : Food balance sheet, Seoul, Korea, (1978)