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Nutrition of Kimchi, and the Organoleptical Characteristics and Marketability in Japan

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INTRODUCTION

Kimchi is a traditional foods in Korea, and it is made by the several vegetables. To determine vitamin, mineral, and dietary fiber content is important to evaluate the nutritive value of kimchi. The research of kimchi is making more progress in Korea than Japan. I have been reported the function of n-3 highly unsaturated fatty acids rich in fish oil(1). Salted fish guts have often used as a sub-material of kimchi. The salted fish guts contain a certain amount of n-3 fatty acids.

In this review, I will introduce the nutritive value of kimchi and the recent topics of physiological function of n-3 fatty acids. Moreover, I will discuss simply on the organoleptical characteristics and marketability of kimchi in Japan.

THE NUTRITIVE VALUE OF KIMCHI

There are difference in each components of Chinese cabbage kimchi between the different data(Table 1)(2,3). However, these data indicate that kimchi contains a large quantity of water and small amounts of proteins, lipids, carbohydrates, minerals and crude fibers. These components of kimchi are similar to those of raw chinese cabbage. Vitamin content of Chinese cabbage kimchi and the desired amount of a day in Japan are shown in Table 2. Chinese cabbage kimchi contains vitamin C and E abundantly. If we take over 300g of the kimchi per day, we can make up for desired amounts of these vitamins. The mineral content of kimchi is similar to that of a main material except sodium content(Table 3)(3). If we eat 300g of the kimchi, we can ingest over one-fourth of the desired amount of calcium and iron per day. The dietary fiber content of chinese cabbage and radish used

Table 1. General components(%) of Chinese cabbage kimchi

Component	Dr. Choi	STFC in Japan*
Water	95.8	88.6
Protein	0.6	2.4
Lipid	0.03	0.2
Carbohydrate	1.5	3.8
Mineral	1.8	4.2
Crude fiber	0.3	0.8

*Standard Tables of Food Composition in Japan(4th ed.)

Table 2. Vitamin content(mg/100g) of Chinese cabbage kimchi and the desired amout(mg) of a day in Japan

Vitamin	Dr. Choi	STFC in Japan*	Desired amount (**Target value)
B_1	0.1	0.04	0.7~1.0
B_2	0.06	0.11	1.0~1.4
C	10~30	20	50
E	2.0	–	7~8**

*Standard Tables of Food Composition in Japan(4th ed.)

Table 3. Mineral content(per 100g) of Chinese cabbage kimchi and the desired amount of a day

Mineral	STFC in Japan*		Desired amount (**Target value)
	Raw Chinese cabbage	The kimchi	
Ca(mg)	35	55	600
P(mg)	36	48	under 1300**
Fe(mg)	0.4	0.6	10~12
Na(mg)	5	1400	500~10000**
K(mg)	230	300	2000~4000**
Mg(mg)	9		300**
Zn(μg)	180		15000(USA)
Cu(μg)	28		1500~3000(USA)

*Standard Tables of Food Composition in Japan(4th ed.)

as main materials of kimchi is shown in Table 4(3). These vegetables contain fair amounts of dietary fibers. If we eat 300g of these kimchi, we can take over 3g of the dietary fibers. These kimchi seems to be good sources of vitamin C and dietary fiber supply.

There are many functional components in the sub-materials of kimchi. Red pepper contains sharp taste components. It has been known that 80% of the sharp taste is caused by capsaicine and dihydrocapsaicine(4).

Table 4. Dietary fiber content(g/100g) of Chinese cabbage and radish

	Soluble	Unsoluble	Total
Chinese cabbage	0.1	1.0	1.1
Radish	0.4	0.8	1.2

Table 5. Nutritional components in salted fish guts(per 100g)

Component	Salted fish guts		
	Opposum shrimps	Anchovy	Pollack roe
Water(g)	64.9	60.3	70.3
Crude protein(g)	10.5	13.3	16.1
Crude fat(g)	0.6	11.4	2.4
Carbohydrate(g)	–	2.3	0
Mineral(g)	–	12.7	5.5
Ca(mg)	681	330	18
P(mg)	287	409	66
Fe(mg)	3.2	3.7	1.4
Na(g)	3.2	2.4	2.6
K(mg)	240	300	200
Retinol(mg)	(3)	(13)	(80)
Carotin(μg)	(0)	(0)	(0)
A potency(IU)	(10)	(43)	(270)
B_1(mg)	0.05	0.10	0.41
B_2(mg)	0.04	0.02	0.19
Niacin(mg)	(1.8)	(8.2)	6.1
C(mg)	(0)	(0)	(0)

( ) : Raw, STFC in Japan(3)

Table 6. EPA and DHA(area %) in the fat of salted fish guts

Fatty acid	Salted fish guts		
	Oppossum shrimps	Anchovy	Pollack roe
EPA ($C_{20\ 5}$, n-3)	14.0	8.8	13.9
DHA ($C_{22\ 6}$, n-3)	15.6	13.7	19.2

The compounds have many physiological functions, especially, promotions of appetite, saliva secretion, acid secretion in the stomach, peristalsis, and energy metabolism. Moreover, they have lowering effects on salt ingestion and blood cholesterol level. It has been well known that garlic contains alliin. The ingredient is converted into allicin under the action of alliinase. Allithiamine is formed by the allicin which is joined to the thiamine. The allithiamine is more absorptive in the body and more effective on the incorporation into blood cells than thiamine. Moresover, the effect of allithiamine is continued longer than that of thiamine. Thus, alliin is effective on the prevention of beriberi and thiamine deficient disease.

The salted fish guts are often used as one of the sub-materials of kimchi. The nutritional components of salted fish guts are shown in Table 5(5). It depends on the components of raw materials. There is a marked difference in lipid content between oppossum shrimps and anchovy. The salted fish guts also contain certain amounts of minerals and vitamins. However, there are the components contained just a little in them. It has been reported that fishes are rich in n-3 highly unsaturated fatty acids. The salted fish guts are also rich in the acids. Table 6(5) shows area % of eicosapentaenoic(EPA ; $C_{20\ 5}$, n-3) and docosahexaenoic(DHA ; $C_{22:6}$, n-3) acids in the lipids of salted fish guts. The EPA and DHA occupy 20~40% of total fatty acids in them. Considering the lipid content, the salted fish guts of anchovy seem to be contained a large amounts of EPA and DHA.

THE PHYSIOLOGICAL FUNCTION OF n-3 FATTY ACIDS

In the last few years, the physiological functions of DHA have eagerly been studied all over the world. Improved effects of DHA on brain function, blood lipid levels, eyesight, and anti-tumor and -inflammatory effects of the fatty acid in experimental animals have been described, and they are expected in humans(1). The interesting results in DHA research have been described in Journal of Japan Society for Lipid Nutrition. Dr. Miyanaga, Gunma University School of Medicine, has been reported clinical effects of DHA in demented patients(6).

Fourteen patients were cerebrovascular dementia and five patients were the senile dementia of Alzheimer type in the DHA supplemented group. Intellectural function was improved in 70% of cerebrovascular dementia and 100% of Alzheimer type dementia after a 6 month treatment of DHA capsule(0.7~1.4g DHA/day). The controls were not improved.

Second International Congress of ISSFAL(The International Society for the Study of Fatty Acids and Lipids) was held in the National Institutes of Health, Bethesda, Maryland, USA, at June, 1995. Dr. Gibson, from Australia, reported that DHA was essential in the development of not only premature brain but also term infant brain(7). Dr. Adams, from Australia, presented that there was a significant correlation between the ratio of erythrocyte long-chain n-6 fatty acids to n-3 fatty acids and the severity of depression(8). Dr. Laugharne, from United Kingdom, reported that dietary supplementation for 6 week with 10g per day of concentrated fish oil led to significant improvements in schizophrenic symptoms(9).

In the poster session, Dr. Hamazaki, from Japan, reported the effect of oral administration of DHA on mental states in the university's students(10). A placebo-controlled, duble blind study has been done for 3 months. The DHA group of 22 persons took 10~12 fish oil capsules containing 1.5~1.8g DHA per day. The control group of 19 persons took a same amount of soybean oil capsules. The mental test showed that there was no change in the DHA group, but the score of primitive aggression against others increased in the control group. He concluded that intake level of DHA might change mental states of humans.

I also reported the efficacy of DHA capsule by a questionnair survey in Japan(11). Completed replies to the questionnair were submitted from 987 persons. About 60% of all replies recognized improvement of physical conditions by the capsule ingestion. However, about 40% reported no change(Fig. 1). Most of people in the group replying "improved enough or slightly" complained of improvements of subjective symptoms in cerebral nerve systems, ophthalmencephalon, risk factors for cardiovascular disease, and inflammation(Table 7).

Many foods added fish oil contained DHA are on the market in Japan. Development of these foods depends on the advancement of deodorization and emulsification techniques. There are formular, canned food, sausage, hamburgers, bread, cookie, milk, cheese, and so on. These foods are useful for the supplementation of DHA.

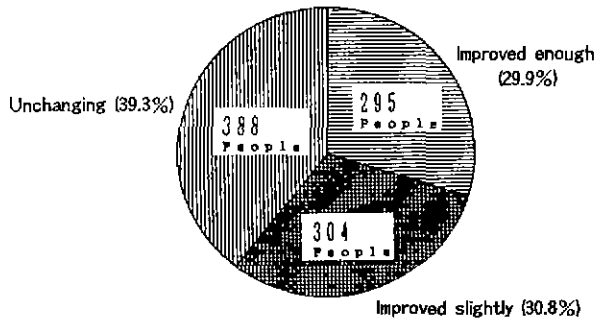

Fig. 1. Changes in physical conditions before and after DHA capsule was ingested.

Table 7. Main subjective symptoms in the group improved enough and slightly

Subjective symptoms	Number	%
Cerebral nerve systems	108	18.1
Refreshed		
Improvement of memory		
Improvement in school record		
etc.		
Optic nerve systems	112	18.7
Improvement of eyesight		
Decrease in the fatigue of their eyes		
Improvement of dim eyes		
etc.		
Allergy and Inflammation	121	20.2
Improvement of atopic dermatitis	59	
Improvement of pollinosis	41	
Improvement of asthma	13	
The others	8	
Cardiovascular systems	65	10.8
Decrease in blood pressure		
Decrease in plasma triglyceride		
Decrease in plasma cholesterol		
etc.		
The others	122	20.4
No comments	71	11.8
Total	599	100.0

THE ORGANOLEPTICAL CHARACTERISTICS AND MARKETABILITY IN JAPAN

Japanese have eaten a small amount of kimchi with

barbecued beef until several years ago. The taste of kimchi of Japan was different from that of Korea. Japanese one was only sharp taste and salty. However, Korean one is mild, complicated and good taste. The assumption of a sum of shipment and the output of pickles in Japan were shown in Table 8(12,13). Kimchi occupies 6% of a sum of shipment of pickles, and it wins third place in the output of pickles in 1994. The production of kimchi is tended to increase year after year (Table 9)(13) because the health effect has recently been reconsidered. Moreover, the imported kimchi from Korea is also increasing because of the wonderful taste. But, the amount is now less than one-tenth of the output in Japan. Japanese tend to like the taste of imported kimchi from Korea. Therefore, the imported one is now dealt in many supermarkets.

Japanese have not a habit of eating kimchi at every meals like Korean. There are little kinds of kimchi in Japan. The marketability of kimchi imported from Korea will increse every year in Japan. Recently, the traditional food of Korea becomes a matter of great concern in Japan. The retort food of samgyetang is now imported from Korea(14). It is sold by mail order in a moderate price. The samgyetang may be becoming extremely popular in Japan. When we eat the samgyetang, we also wish to eat kimchi. These facts will increase the marketability of kimchi. Eating of kimchi with the traditional foods of Korea will be of use for not only the promotion of human health, but the understanding of Korean culture in Japan.

Table 8. Assumption of a sum of shipment and output of pickles in 1994(12)

Pickle	Shipment ($\times 10^8$ yen)	(%)	Output ($\times 10^4$ ton)
Asa-zuke	1650	30	33.2
Takuann-zuke	990	18	12.8
Ume-zuke	605	11	
Shoga, rakyou-zuke	440	8	7.0
Kizami-zuke	385	7	9.1
Kimchi	330	6	9.3
Na/zuke	330	6	
Fukujin-zuke	220	4	
Kasumiso-zuke	220	4	
Others	330	6	

Table 9. Change of output of kimchi in Japan(13)

Year	1986	1988	1990	1992	1994
$\times 10^4$ ton	5.6	5.9	8.3	7.4	9.3

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