J Food Sci. Nutr.
Vol 1, No. 1, p. 46~52(1996)

Effects of Processing Conditions on Some Characteristics of Dongchimi Juice

Dong-Hee Kim†, Yun-Kee Chun* and Woo-Jung Kim**

Dept. of Food and Nutrition, Yuhan Junior College, Puchon 422-749, Korea
**Jung Poong Co., Ltd., Seoul 138-150, Korea*
***Dept. of Food Science and Technology, Sejong University, Seoul 143-747, Korea*

Abstract

Effective method for the preparation of Dongchimi juice was developed by addition of NaCl, sucrose and hydrolytic enzymes before fermentation and addition of Dongchimi juice during fermentation. The radish was ground and suspended in water(1 : 1, w/v) with addition of spices(garlic, green onion and ginger) followed by fermentation at 25°C. The addition of 2% NaCl and 0.5~2.0% sucrose resulted in significant increase of solid content and it was also improved by the addition of polysaccharide hydrolyzing enzyme during fermentation. When the fermented juices of pH 5.4 or pH 4.4 were added by 15% of total weight before(pH 5.4 juice) and during(pH 4.4 juice) fermentation, a significant increase in solid content after 24hrs of fermentation was resulted. The combined method of addition of 2% NaCl, 1.0% sucrose, 0.1% Viscozyme and 10% of fermented juice of pH 5.4 and 4.4 before and during fermentation improved solid content, reducing sugar, color and showed little effect on viscosity. The organoleptic characteristics were also improved by the combined method.

Key words: Dongchimi juice, fermentation, quality characteristics

INTRODUCTION

The Dongchimi, one of the watering radish kimchi, has been a very favorable fermented vegetable side dish in Korea. The quality characteristics of Dongchimi are primarily affected by the species and amount of radish and fermentation conditions. Generally, the Dongchimi radish and its juice are more tasteful when fruits were added along with some spices such as garlic, fresh hot pepper and ginger(1).

Many workers investigated the effect of fermentation temperatures and salt concentrations on pH and acidity of Dongchimi(2,3), prevention of tissue softening of radish root by pre-heating treatment(4), changes in chemical, rheological and sensory properties of Dongchimi during fermentation(5-7) and the effects of fermentation temperature and salt concentrations on pH and acidity of Dongchimi(8). Heat treatment and addition of organic or inorganic salts were found to be effective for extension of storage stability(9). Changes in color, turbidity and some flavor compounds during fermentation were also studied(10,11).

Such studies were mainly focused on the Dongchimi itself as the sidedish at the dinner table. Even though industrial interest on Dongchimi juice as an fermented vegetable juice is now growing, little works have been carried out except the report of reduction of fermentation time for preparation of Dongchimi juice by addition of sugar, fermented Dongchimi juice and enzymatic hydrolysis of NaCl, ground radish(12).

In order to develop the processing method of Dongchimi juice, addition effects of salt, sugar and fermented Dongchimi juice before and during fermentation and enzymatic hydrolysis of ground radish on the physicochemical and sensory characteristics of Dongchimi juice, were investigated.

MATERIALS AND METHODS

Materials

The radish of the Baebureung variety was used as raw materials, 16~20cm long, diameter of 5~7.5cm and weight of 680~820g. The leaf portion of the radish was removed and the radish was washed with tap water. After the surface water on the radish was dried with clean tissue, it was ground using a waring blender and

†Corresponding author

stored in the freezer until use. The fresh garlic, ginger and green onion purchased from a local market and were ground and stored in a freezer.

The enzymes used were Viscozyme and Celluclast (NOVO industry, Denmark) which have enzymatic activities of arabinase, cellulase, xylanase, hemicellulase, β-glucosidase and 1,4-β-D-glucanase. The chemicals used in this experiment were analytical grade.

Preparation of Dongchimi Juice

Ground radish suspension was prepared by mixing the ground radish in the same volume of water(1 : 1, w/v), 3% of green onion, 1% of garlic and 0.5% of ginger. After adding salt(1.0~5.0%), sugar(0.5~2.0%) and enzymatic hydrolysis with polysaccharide hydrolyzing enzymes, respectively, the ground Dongchimi was fermented at 25°C for 60 hours. The fermented ground Dongchimi was filtered for analysis.

Solid concentration

The solid concentration of Dongchimi juice was determined by measuring the absorbance at 440nm with spectrophotometer(Milton Rey Co., U.S.A.). The concentration of solid content was calculated from the absorbance using the standard curve(Fig. 1) and the amounts of NaCl added were substracted.

Reducing sugar and salt

The reducing sugar in the juice was measured by the Somogy method(13) and expressed as a glucose concentration(mg%). The salt concentration was measured by the Mohr method(14).

Color

The values of Hunter 'L', 'a', 'b' of Dongchimi juice were measured using a digital color measuring/difference calculation meter(Nippon Denshoku Kogyo., LTD).

Viscosity

Viscosity of Dongchimi juice was measured by Brookfield viscometer(Model-DVII, Brookfield Engineering Labs, U.S.A.). A 45ml of Dongchimi juice was transferred into a conical tube(7.5cm length×3.5cmφ) and measured with spindle No. 4 and spining 100rpm at 20°C after 2min.

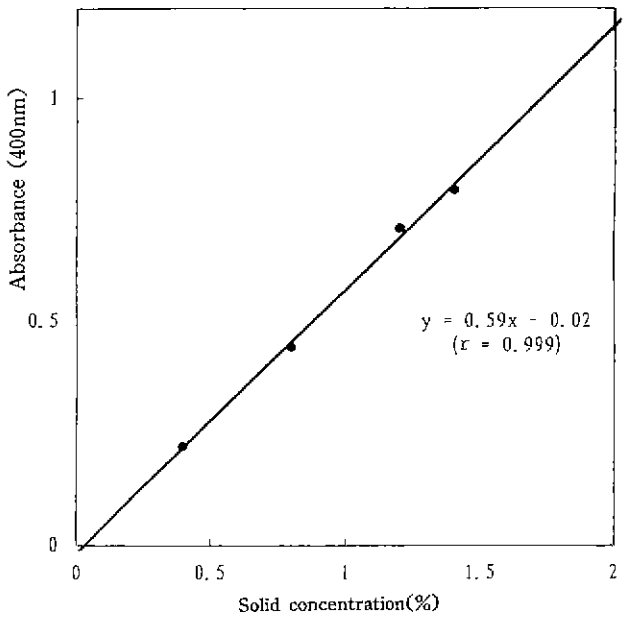

Fig. 1. Relationship between absorbance and solid concentration of Dongchimi juice.

Sensory evaluation

Sensory characteristics of Dongchimi juice were compared by multiple comparison test and 9 point category scales with the control(R) which was prepared with addition of the salt and spices only and had a pH of 4.2 approximately. The flavor of Dongchimi juice was characterized by nine different tastes and odors : acidic taste and odor, moldy taste and odor, fresh radish taste and odor, fresh sourness taste and odor, and enzymatic odor. The intensity of flavor was scored by 9 point category scales(1; very week compared to R, 5; equal to R, 9; very strong compared to R). The total acceptability was evaluated by the ranking test.

Eight panelists were selected and trained before the sensory test. The data obtained was statistically analysed by ANOVA and Duncan's multiple range test for its significancy.

RESULTS AND DISCUSSION

Solid concentration

The effects of NaCl concentration of brine solution on the solid concentration of Dongchimi juice during fermentation at 25°C are shown in Table 1. As the NaCl concentration increased the solid concentration was generally decreased. The initial solid concentration of

Table 1. Changes in solid concentration of Dongchimi juice during fermentation at 25°C as affected by NaCl concentration (%)

NaCl addition	Fermentation time(hours)					
	0	12	24	36	48	60
Control	0.63	0.41	0.61	1.24	1.50	1.64
1% NaCl	0.63	0.38	0.78	0.76	0.70	0.76
2% NaCl	0.63	0.45	0.85	0.70	0.63	0.63
3% NaCl	0.63	0.44	0.48	0.54	0.50	0.54
4% NaCl	0.63	0.50	0.56	0.58	0.42	0.46
5% NaCl	0.63	0.44	0.44	0.44	0.54	0.54

Table 2. Changes in solid concentration of Dongchimi juice during fermentation in 2% NaCl solution at 25°C as affected by sucrose concentration (%)

NaCl addition	Fermentation time(hours)					
	0	12	24	36	48	60
Control	0.63	0.45	0.85	0.70	0.63	0.63
0.5% sucrose	1.13	2.10	0.70	0.72	1.26	0.72
1.0% sucrose	1.63	0.96	0.80	0.90	1.40	0.80
1.5% sucrose	2.13	2.10	0.66	0.82	0.84	0.86
2.0% sucrose	2.63	2.20	1.72	0.90	1 72	0.80

about 0.63% before fermentation was steadly increased in the Dongchimi juice without salt addition during fermentation, while the NaCl added juice was changed relatively less. The difference between saltless and salt added juice is probably due to the different microbial growth in Dongchimi juice. At more than 3% of NaCl the changes of the concentration were significantly reduced. After 36 hours of fermentation, where the pH reached optimal pH 4.0 from the result of previous report(12), the solid concentration was higher at 1~2% NaCl of brine solution compared to 3~5% NaCl. This result was similar to Ku's report (15). The solid concentration was rather reduced after 12 hours of fermentation followed by an increase thereafter. The decrease in solid during initial fermentation may be due to the use of soluble solid, primarily sugar by microbes for their metabolism before further hydrolysis of insoluble materials by microbial enzymes.

Table 2 showed the changes of solid concentration of the juice affected by sugar addition. The 2% NaCl addition to brine solution was chosen from the results of NaCl effects. The control, which was fermented in 2.0% NaCl without sugar addition, was steadly increased in solid concentration; except 24 hours which reached maximum. As the sugar was added from 0.5% to 2.0% the reduction of soluble solid in juice was more significant. At the end of fermentation, the soluble solid content in juice became a little different. This result indicates the added sugar inhanced the microbial growth and fermentation. At optimally fermented Dongchimi juice having pH 4.0, the solid concentration was in the range of 0.8~0.9%

Enzymatic hydrolysis of ground radish with Viscozyme and Celluclast, the polysaccharide hydrolyzing enzymes, before fermentation was investigated on the soluble solid content in Dongchimi juice during fermentation(Table 3). The solid concentration in Dongchimi juice was significantly increased in the initial juice(zero time) from 0.74% to 0.82~0.84%. As the other data of NaCl and sugar effects, there was a decrease in soluble solid during 12~24 hours of the initial fermentation, followed by an increase. After 36 hours Celluclast resulted in significant high concentration of 1.1~1.6% than those values of Viscozyme.

From the previous report(12), addition of fermented Dongchimi juices having pH 5.4 and 4.4 before and during fermentation improved the fermentation rate. Table 4 showed the results of the addition effects of fermented juice in three different methods. When the pH 5.4 juice was added into 2% NaCl brine solution by 5~15% before fermentation, the solid concentration was not much affected. The similar results were also obtained from the fermented juice addition of pH 4.4 juice during fermentation and both pH 5.4 and 4.4

Table 3. Changes in solid concentration of Dongchimi juice during fermentation in 2% NaCl solution at 25°C after enzymatic hydrolysis for 1 hour (%)

Enzyme addition	Fermentation time(hours)					
	0	12	24	36	48	60
Control	0.74	0.56	0.45	0.99	0.82	0 76
0.1% Viscozyme	0.82	0.80	0.60	0.94	1.40	0.90
0.2% Viscozyme	0.82	0.46	0.36	0.48	1.06	1.12
0.1% Cellulast	0.84	0.80	1.38	1.60	1.48	0.84
0.2% Cellulast	0.84	0.66	1.18	1.10	1.22	0.88
Combined method[1)]	1.30	0.30	0.42	1.34	0.64	0.48

[1)]Affected by addition of 2% NaCl, 1% sucrose and two different fermented Dongchimi juices of pH 4.4, pH 5.5 and enzymatic hydrolysis with 0.1% Viscozyme

Table 4. Changes in solid concentration of Dongchimi juice during fermentation in 2% NaCl solution at 25°C as affected by addition of two different Dongchimi juices of pH 5.4 and 4.4 (%)

Dongchimi juice addition		Fermentation time(hours)					
		0	12	24	36	48	60
Control		0.63	0.45	0.85	0.70	0.63	0.63
pH 5.4	5%	1.20	0.82	0.72	0.48	0.60	1.12
	10%	1.28	0.70	0.74	0.72	0.66	0.94
	15%	1.28	0.82	0.68	0.50	0.52	0.96
pH 4.4	5%	1.20	0.88	1.04	0.74	1.20	1.30
	10%	1.24	0.90	0.92	1.04	1.02	1.02
	15%	1.34	0.70	0.80	0.88	0 86	1.24
pH 5.4 + pH 4.4	5%	1.22	0.78	0.78	0.88	1.20	1.04
	10%	1.24	0.82	0.90	1.28	1.40	1.62
	15%	1 24	0.68	0.84	1.32	1.78	2.38

juices before and during fermentation. Even though some of the data after 36~48 hours gave a little higher concentration for both fermented juices addition, the solid concentration was not much improved.

From the above results, addition of 2% NaCl, 1% sucrose and both fermented juice having pH 5.4 and 4.4 and enzymatic hydrolysis with 0.1% Viscozyme, which reduced the fermentation time more significantly than Celluclast(12), were selected for combined method to prepare Dongchimi juice. Table 3 showed that the solid concentration in combined method Dongchimi juice was increased from 0.74% to 1.30% before fermentation. There was a decrease in soluble solid during 12~60 hours of fermentation; except 36 hours which reached maximum, 1.34%.

Reducing sugar

Table 5 showed the changes of reducing sugar content of ground radish as affected by enzymatic hydrolysis at 50°C before fermentation. As the enzymatic hydrolysis progressed, the reducing sugar content was generally increased. Addition of 0.2% Viscozyme resulted a rapid increase in reducing sugar and reached to maximum 1.346mg% within 1 hour, then was decreased a little, thereafter, while the values of 0.1% Viscozyme were rather slowly increased. After 1 hour hydrolysis with Celluclast also showed a smiliar result to those reducing sugar values of Viscozyme addition. The reducing sugar content in enzymatic hydrolyzed ground radish for 1 hour was significantly high when those values were compared to the control. Since 1 hour of hydrolysis of ground radish was effective for reduction of fermentation time of Dongchimi juice from previous report(12), one hour of hydrolysis with Viscozyme and Celluclast was examined for their effect on reducing sugar of Dongchimi juice during fermentatioin. The result(Table 6) showed that the reducing sugar content in Dongchimi juice with enzymatic hydrolysis for 1 hour was a little increased during 12 hours of fermentation from 1.229mg% to 1.478~1.624mg%.

Table 5. Changes in reducing sugar of aqueous suspention of ground radish during enzymatic hydrolysis with Viscozyme and Celluclast at 50°C (mg%)

Enzyme addition	Hydrolysis time(hours)					
	0	0.5	1.0	2.0	3.0	4.0
Control	1.053	1.082	1.156	1.136	1.147	1.158
0.1% Viscozyme	1.053	1.244	1.147	1.136	1.215	1.294
0.2% Viscozyme	1.053	1.215	1.346	1.165	1.150	1.170
0.1% Celluclast	1.053	1.142	1.206	1.267	1.273	1.235
0.2% Celluclast	1.053	1.177	1.235	1.258	1.259	1.345

Table 6. Changes in reducing sugar of Dongchimi juice during fermentation in 2% NaCl solution at 25°C after enzymatic hydrolysis for 1 hour (mg%)

Enzyme addition	Fermentation time(hours)					
	0	12	24	36	48	60
Control	1.229	1.361	1.215	1.229	0.922	0.790
0.1% Viscozyme	1.229	1.478	1.449	1.273	1.156	0.863
0.2% Viscozyme	1.229	1.478	1.449	1.419	1.332	0.980
0.1% Celluclast	1.229	1.595	1.449	1.331	0.863	0.795
0.2% Celluclast	1.229	1.624	1.449	1.273	1.185	1.039
Combined method[1)]	1.229	1.361	1.229	1.156	0.966	0.878

[1)]Affected by addition of 2% NaCl, 1% sucrose and two different fermented Dongchimi juices of pH 4.4, pH 5.5 and enzymatic hydrolysis with 0.1% Viscozyme

Table 7. Changes in Hunter values and viscosity of Dongchimi juice prepared by combined of addition of spices, 2% NaCl, 1% sucrose and Dongchimi juices of pH 5.4 and 4.4 and enzymatic hydrolysis with 0.1% viscozyme during fermentation at 25°C

Hours	Control				Combined method			
	L	a	b	Viscosity (cps)	L	a	b	Viscosity (cps)
0	15.7	-0.3	-1.3	10	18.4	-0.3	-1.8	10
6	14.1	-0.3	-2.4	6	15.7	-2.0	-1.3	6
12	14.1	-0.3	-2.4	8	12.4	-0.2	-2.2	8
18	13.6	-0.2	-1.9	8	14.1	-0.3	-2.4	8
24	13.0	-0.2	-1.3	8	15.2	-0.3	-2.1	6
30	14.7	-2.1	-1.6	10	18.0	-1.8	-1.4	10
36	18.4	-1.8	-0.8	10	18.8	-1.8	-1.2	10
48	14.1	-0.3	-2.4	10	17.5	-0.3	-0.9	10
60	14.1	-0.3	-2.4	6	15.7	-0.3	-1.3	8

After 12 hours Viscozyme, Celluclast and control were decreased during fermentation. Combined method Dongchimi juice was prepared by addition of 2% NaCl, 1% sucrose and two different Dongchimi juices of pH 5.4 and pH 4.4 and enzymatic hydrolysis with 0.1% Viscozyme. The combined method showed a little increase in reducing sugar within 12 hours of fermentation followed by a significant decrease, thereafter, changes of control in reducing sugar were similar to combined method.

Color, viscosity and sensory evaluation

The changes of viscosity and color of Dongchimi juice during fermentation by the combined method of addition of 2% NaCl, 1% sucrose and 10% of two fermented Dongchimi juices of pH 4.4 and 5.5 and enzymatic hydrolysis with 0.1% Viscozyme were shown in Table 7. The changes of viscosity and color of combined method were similar to control which was fermented by addition of only 2% NaCl and spices. As the fermentation progressed, viscosity of control and combined meth-

Table 8. Changes in odor and taste of Dongchimi juice prepared by combined method during fermentation at 25°C

Sensory description	Fermentation time(hours)					F value
	12	24	30	36	60	
Aciditic odor	5.00^{b}	5.12^{b}	5.75^{ab}	6.00^{a}	7.00^{a}	2.88*
Moldy odor	5.13	4.63	4.50	4.50	5 50	0.67
Fresh radish odor	5.00	4.75	3.88	3.75	3.63	1.26
Fresh sourness odor	4.63	4.88	5.75	5.88	6.13	1.24
Enzymatic odor	5.88	5.38	5.38	4.63	4.30	0.82
Total intensity	5.50	4.88	5.38	5.38	7.00	2.15
Aciditic taste	4.63^{c}	4.50^{c}	5.50^{bc}	6.38^{ab}	7.75^{a}	6.43**
Moldy taste	6.13	4.50	4.80	6.00	6.00	2.44
Fresh radish taste	5.75^{a}	5.13^{ab}	4.13^{abc}	3.75^{bc}	2.75^{c}	3.57*
Fresh sourness taste	4.88	4.30	6.00	5.13	6.50	1.90
Total intensity	5.00^{b}	5.00^{b}	5.38^{b}	4.88^{b}	7.13^{a}	3.20*
Total acceptability	29.0^{b}	23.0^{ab}	12.0^{a}	27.0^{b}	29.0^{b}	3.06*

^{abc}Mean scores within raw followed by the same letter are not significantly differrent at the 5% level using Ducans Multiple Ranges test

*$p<0.05$ in ANOVA test **$p<0.01$ in ANOVA test

od Donchimi juice was slightly increased from 6cps to 10cps.

Changes of color showed Hunter 'L' values of combined method Dongchimi juice were more increased after 24 hours of fermentation than those values of control and 'a' values were similar to control during fermentation. Hunter 'b' values were a little increased in initial fermentation of 24 hours and then decreased thereafter. The color changes of Dongchimi juice may be due to the changes of solid content and color pigment in Dongchimi juice by fermentation.

Sensory characteristics of Dongchimi juice prepared by combined method showed that fresh radish odor and taste and enzymatic odor decreased while acidic and fresh sour flavor increased during fermentation (Table 8). The total intensity of odor and taste significantly increased after 60 hours of fermentation. The statistical significancy of acidic and fresh radish flavor and total intensity of taste was 5% and acidic taste was 1%. The total acceptability was highest for the juice fermented for 30 hours when the juice was measured near pH 4.0 from previous report(12).

ACKNOWLEDGEMENTS

This paper is the part of the work supported by a research grant from Yuhan Junior College

REFERENCES

1. Yum, C A, Jang, M. S. and Yun, S J. : Korean food Hyoil Publishing, Seoul, p.236(1992)
2. Yun, J. W., Kim, J. K., Lee, J. K. and Kim, W J. : Effect of microwave heating and salts addition on pH and acidity of Kakdugi during fermentation. *J. Korean Agric. Chem. Soc.*, **34**, 213(1991)
3. Yun, J. W., Kim, J. K. and Kim, W. J. : Combined effects of microwave heating and salts addition on physical characteristics of Kakdugi. *J. Korean Agric. Chem. Soc.*, **34**, 219(1991)
4. Yook, C., Chang, K., Park, K. H. and Ahn, S. Y. : Preheating-treatment for prevention of tissue softening of radish root kimchi. *Korean J. Food Sci. Technol.*, **17**, 447 (1985)
5. Jhee, O. H. : The changes of nonvolatile organic acid in radish kimchi with different content of salt during fermentation. Chung Nam National University mastethesis(1987)
6. Kang, K. O., Ku, K. H., Lee, J. K. and Kim. Y. J. : Changes in physical properties of Dongchimi during fermentation. *Korean J. Food Sci. Technol.*, **23**, 262(1991)
7. Kang, K. O., Sohn, H. J. and Kim, W. J. : Changes in chemical and sensory properties of Dongchimi during fermentation. *Korean J. Food Sci. Technol.*, **23**, 267(1991)
8. Kang, K. O.. Kim, J. K. and Kim, W. J. : Effect of heat treatment and salts addition on Dongchimi fermentation. *J. Korean Soc. Food Nutr*, **20**, 565(1991)
9. Kang, K. O., Ku, K H. and Kim, W. J. : Combined effect of brining in hot solution and salts mixture addition for improvement of storage stability of Dongchimi. *J. Korean Soc. Food Nutr.*, **20**, 559(1991)
10. Lee, M. R. and Rhee, H. S. : A study on the flavor compounds of Dongchimi. *Korean J. Soc. Food Sci.*, **6**, 1(1990)
11. Moon, S. W., Cho, D. W., Park, W. S. and Jang, M. S. : Effect of salt concentration on Tongchimi fermentation. *Korean J. Food Sci. Technol.*, **27**, 11(1995)
12. Kim, D. H., Chun, Y. K. and Kim, W. J. : Reduction of fermentation time for preparation of Dongchimi juice. *Korean J. Food Sci. Technol.*, **26**, 726(1994)
13. A.O.A.C. : *Official methods of analysis.* 14th ed., Associa-

tion of official analysis chemist S. Washington, D. C., p.56 (1984)
14. Ku, K. H., Kang, K. O. and Kim, W. J. : Some quality changes during fermentation of Kimchi. *Korean J. Food Sci. Technol.*, **20**, 476(1988)
15. A.O.A.C. : *Official methods of analysis*. 14th ed., Association of official analytical chemists. Washington, D. C., p.1006(1984)

(Received May 25, 1996)