

工學博士 學位論文

# 가 가

2002 7

釜慶大學校 大學院

食 品 工 學 科

趙 鏞 範

工學博士 學位論文

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가

指導教授 李 養 鳳

論文 工學博士 學位論文 提出

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趙 鏞 範

趙 鏞 範    工學博士 學位論文    認 准

2002    6

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# **Quality Evaluation of Processed Foods by Adding Freeze-Dried *Kimchi* Powder**

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*Department of Food Science and Technology, Graduate School,  
Pukyong National University*

*Kimchi* powder made by fermentation and freeze-drying was added to Western foods of sauce, soup, pizza, cracker and bread. Flavor qualities of the processed fusion foods evaluated by measuring the volatile compounds and sensory evaluation.

1. The optimum conditions of the fermented *kimchi* for the best flavor quality of freeze-drying were the ranges of pH4.0 pH4.7 and acidity 0.5 0.8. The number of volatile compounds identified from extracts of the freeze-dried *kimchi* powder was 24, which contained 7 alcohols, 5 esters, 5 acids, 3 sulfur-containing compounds, 2 aldehydes, 1 oxygen-containing and 1 other. Among the identified compounds, the most abundant compound was eugenol(39.40%), followed as the order of dodecanoic acid(4.91), acetic acid(1.70%), methyl 2-propenyl disulfide(1.52%), hexanal(1.51%) and 2-pentylfuran(1.18%). And these compounds affected the flavor quality of *kimchi* powder.

2. The optimum amount of adding the *kimchi* powder for *kimchi* sauce was 20%, among the treatments of 0%, 10%, 20% and 30%. The compounds identified from the *kimchi* sauce were 5 aldehydes, 4 alcohols, 4 acids, 3 Sulfur-containing compounds, 1 ketone and 6 others. The aldehydes were related to the flavor of sweet candy, and acids were related to sour flavor. Sulfur-containing compounds were thought to come from the sour sources of *kimchi* and garlic.

3. The soup of adding 10% *kimchi* powder had the taste of buttery taste, and the soup of adding 30% *kimchi* powder had the taste of salty and spice. The best amount of adding *kimchi* powder for *kimchi* soup was 20% by sensory evaluation. The number of volatile compounds identified from the *kimchi* soup was 25, which contained 11 alcohols, 4 aldehydes, 3 terpenes, 3 esters, 1 sulfur-containing compound and 3 others. These compounds affected the flavor quality of *kimchi* powder-added soup.

4. The optimum amount of *kimchi* powder for making a sauce of *kimchi* pizza was 20% among the treatments of 0%, 10%, 20% and 30%. By the sensory evaluation, the flavor quality of the pizza made by adding 2% *kimchi* powder in dough was better than that of 20% treatment in *kimchi* pizza sauce.

5. In *kimchi* crackers, the differences of adding 2% and more than

4% *kimchi* powder were significantly recognized by the difference test of triangle test at the  $p < 0.05$  and  $p < 0.001$ , respectively. By ranking test of sensory evaluation, the best amount of adding *kimchi* powder for *kimchi* cracker was 4%, followed by the order of 4%, 8%, 6%, 10% and 2%. By the quality descriptive analysis of sensory evaluation, the best scores for *kimchi* crackers on the sensory aspects of aroma, color and taste, overall were the crackers of adding 6%, 8% or 4% *kimchi* powder, respectively.

6. The bread of adding 1% *kimchi* powder had the volume of 3,150 Ml, and both breads of adding 2%, 3% *kimchi* powder 3,200 Ml. These were thought to be fermented better than that of the control bread of 3,000 Ml.

In the studies on the change of moisture contents of *kimchi*-added bread, the moisture contents of breads of adding 1%, 2%, 3% *kimchi* powder were similar to that of the control bread, but the moisture content of control bread during 6 day storage was sharply decreased to the loss of 4.0%, showing the hardness, compared to the *kimchi*-added breads of the moisture loss of 1.5%.

In the case of hardness of bread during storage, the fresh *kimchi*-added bread was two times softer than that of the control bread. The hardness of the 6 day-stored breads of adding 1%, 2% *kimchi* powder was similar to that the 4 day-stored bread of control. The hardness of the 6 day-stored bread of adding 3% *kimchi* powder was similar to that of the 1 day-stored bread of control.

•

가 1600  
( , 1995).  
『 (詩經)』 (菹) , 『  
(呂氏春秋)』 . (漢) (釋名) “  
(阻)  
가 .” ( , 1994).  
(1990) “ ,  
.” . 가  
가 1800 .  
가  
( , 1995).  
가  
(Cho et al., 1995: Kang et al., 1983: Lee et al., 1997: , 1979).

가

(Cha et al., 1988; Kawada et al., 1986; Lee et al., 1997; Lee et al., 1984; Park et al., 1991; Park et al., 1996; Song et al., 1996).

(Park et al., 1991; Kim et al., 2000).

가

(Cho et al., 1988 ; Cho et al., 1996 ; Goidman et al., 1996 ; Han, 1995 ; Lee et al., 1997 ; Stacy et al., 1993 ; 1997 ; , 1990 ; , 1994 ; , 1995 ; , 1986).

가

가

(Hwang, et al., 1998 ; Han al., 1995).

, , , , 180

가 ( , 1996).

가 가 ,

(Woo et al., 1988 ; Lee et al., 1996 ; Kim et al., 2000 ; Yu et al., 1990 ; Song et al., 1997 ; lee et al., 1993 ; Park et al., 1995 ; Kim et al., 1995 ; Cho et al., 1993 ; Lee, et

al., 1996). , 가  
(Choi et al., 1997 ; So et al., 1995 ; Yu et al.,  
1990 ; Yu et al., 1995 ; Kim et al., 2001 ; Kim et al., 2001 ; Song et al., 1998 ;  
Song et al., 1997).

가 가  
가 . ‘ ,  
,  
‘ (i) ’ ,  
,  
‘ , (Han et al., 200  
0 ; Koo et al., 1999). , 가  
가 , 20  
(Hong et al., 1988 ; Jung et al., 199  
7 ; Whang et al., 1999).

‘ , , 6  
(Kim et al., 1991 ; Choi et al., 1997 ; Lee et al., 1998 ;  
Lee et al., 1999 ; Choi et al., 1997). DHA ,  
, ,  
, (Cho et al., 1997 ; Kim et al.,  
1997 ; Lee et al., 2001 ; Lee et al., 1998 ; Choi et al., 1997 ; Choi et al., 199  
7 ; Park et al., 2002).

가

가

가

가

.

fusion food

가

가

(Chang et al., 2000).

가

.

가

(Choi, 2001).

.

가 가

,

가

.

, , ,

가

(Jung et al., 1997).

.

.

가

(Park et al., 1998).



## II.

### 1.

#### 1.1.

8%  
 , 가  
 100 g 가 3 g, 2 g, 1.5 g, 0.5  
 g 가 , 9 cm 가 8 cm pet  
 .

#### 1.2. 가

( , ), ( , ), ( ,  
 ), ( , ), ( 99%, , ) ( ,  
 , ), ( , ), A,1, (Nabisco Foods, Inc.,  
 ), (Morehouse Mustard Food, USA), ( 100%, ,  
 ), 가 ( , ), ( , ), 가 ( ,  
 ), ( , ),  
 (roux) . , ,  
 .

### 1.3. 가

50g, 200g, 150g, 200g, 50g,  
10g, 2 3 , ( ) 50cc, 가 10g, 10g,  
30g, 50g, 10g, 가 Table 1

.

### 1.4. 가

#### 1.4.1. 가

(dough) , 3  
가 가 , 가 ( ), ( ), ( ), (   
(French ), ( ), 가 , (   
) Park (2000)

10 가 0.6 0.8%

, , , ,

.

#### 1.4.2. 가

( ), ( ), ( , 100%), 가 (   
( ), ( ) , , 가

. ,

.

### 1.4.3. 가

가 가  
1% 가 1%, 2%, 3% 가 , sugar,  
butter, yeast, yeast food, salt 가  
, 가 Table 2 .

**Table 1. Materials and contents of *kimchi* soup**

| <b>Materials</b>                  | <b>Contents (g)</b> |
|-----------------------------------|---------------------|
| Flour                             | 1,000               |
| Beef                              | 220                 |
| Onion                             | 210                 |
| Dasida                            | 30                  |
| Grounded sesame                   | 110                 |
| Dried boletus                     | 30                  |
| Sugar                             | 150                 |
| Salt                              | 90                  |
| Ginger juce                       | 20                  |
| Garlic                            | 90                  |
| Milk powder                       | 140                 |
| Starch                            | 200                 |
| Freeze dried <i>kimchi</i>        | 120                 |
| Freeze dried <i>kimchi</i> powder | 100                 |
| Tomato paste                      | 130                 |
| Butter                            | 140                 |

**Table 2. Ratios of dough preparation of adding *kimchi* powder**

(Unit:%)

| Ingredient           | Control | Amount of of the added kimchi powder |       |       |
|----------------------|---------|--------------------------------------|-------|-------|
|                      |         | 1%                                   | 2 %   | 3 %   |
| <i>Kimchi</i> powder | 0.0     | 1.0                                  | 2.0   | 3.0   |
| Wheat flour          | 86.9    | 85.9                                 | 84.9  | 83.9  |
| Sugar                | 5.0     | 5.0                                  | 5.0   | 5.0   |
| Salt                 | 2.0     | 2.0                                  | 2.0   | 2.0   |
| Butter               | 4.0     | 4.0                                  | 4.0   | 4.0   |
| Yeast                | 2.0     | 2.0                                  | 2.0   | 2.0   |
| Yeast food           | 0.1     | 0.1                                  | 0.1   | 0.1   |
| Total                | 100.0   | 100.0                                | 100.0 | 100.0 |

## 2.

### 2.1.

#### 2.1.1.

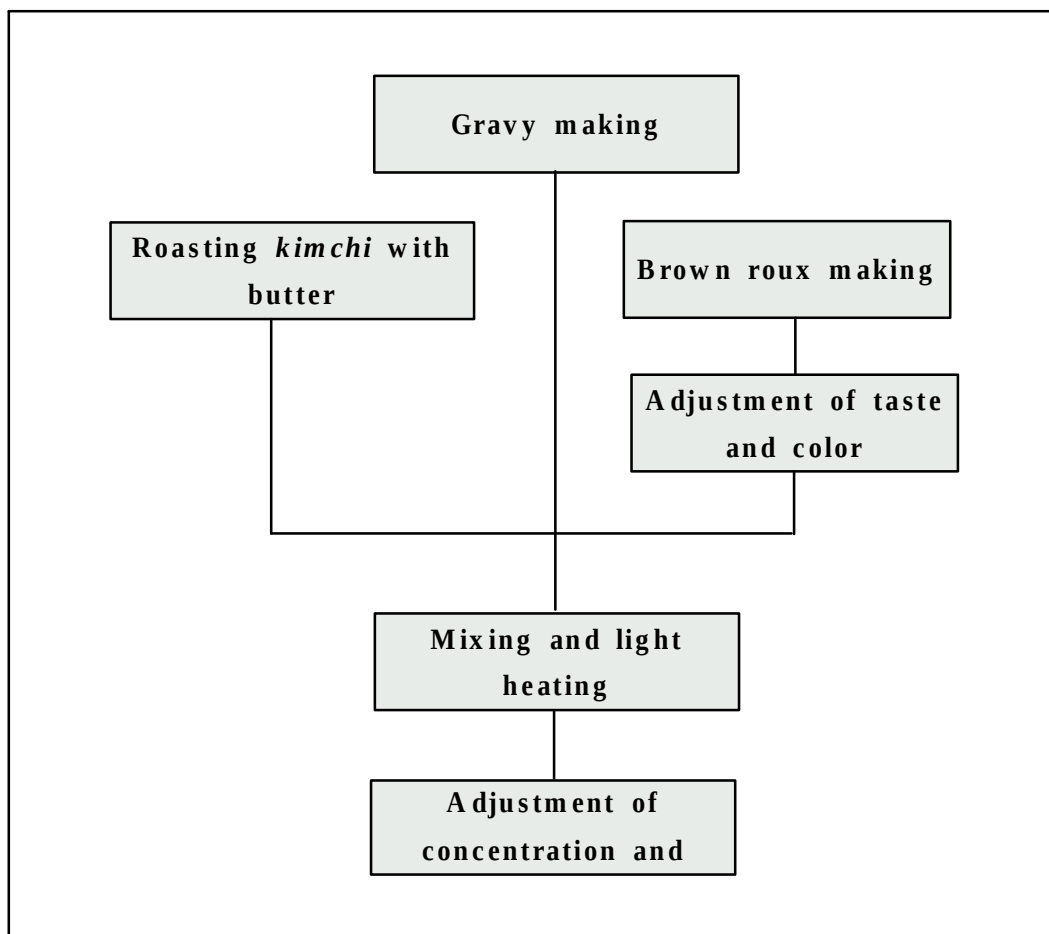
가 4 Park  
8% ( 25 ) 12  
2 1 . 가  
1.8% , 4 × 4 cm  
100 g 가 3 g, 2 g, 1.5 g, 0.5 g 가  
. 3%가 ,  
9 cm 가 8 cm pet 300 g 10  
,  
가  
.

#### 2.1.2.

- 70 2  
(PVPFD- 10A, Korea) 24  
.  
가  
가  
.

## 2.2. 가

Fig. 1 . , , , ,  
 , 가 (roux)  
 ,  
 . 200 g 가 200 g  
 , 2 pH 4.  
 0 4.7, 0.5 0.8% ,  
 20%가 가 , 5 6%, 3 5% , , 가  
 , , , , , 45  
 50% 가 .



**Fig . 1.** Schematic diagram of a procedure for making *kimchi* steak sauce.

### 2.3. 가

가 ( )

Table 1

Fig. 2

14 pH 4.0

4.7, 0.5 0.8%

가 170 ( ) 2

1000 g 140 g

### 2.4. 가

#### 2.4.1. 가

50g, 200g, 150g, 200g, 50g,

10g, 2 3 , ( ) 50cc, 가 10g, 10g,

30g, 50g, 10g, 가

가

10%, 20% 30%

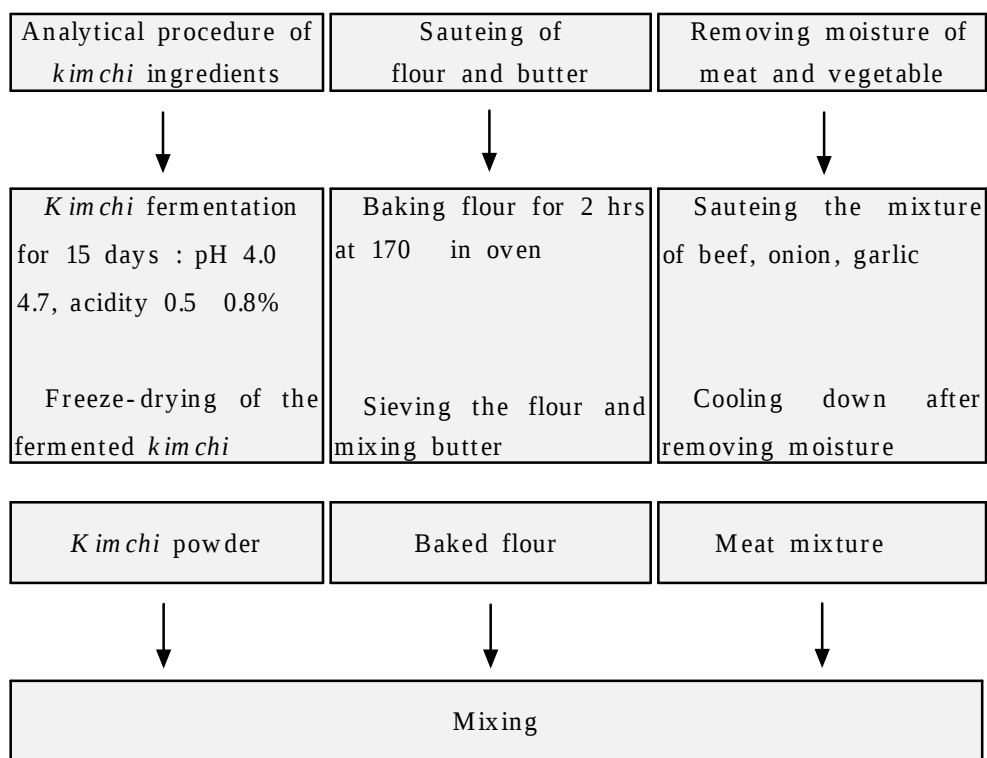
#### 2.4.2. 가

가 , , ,

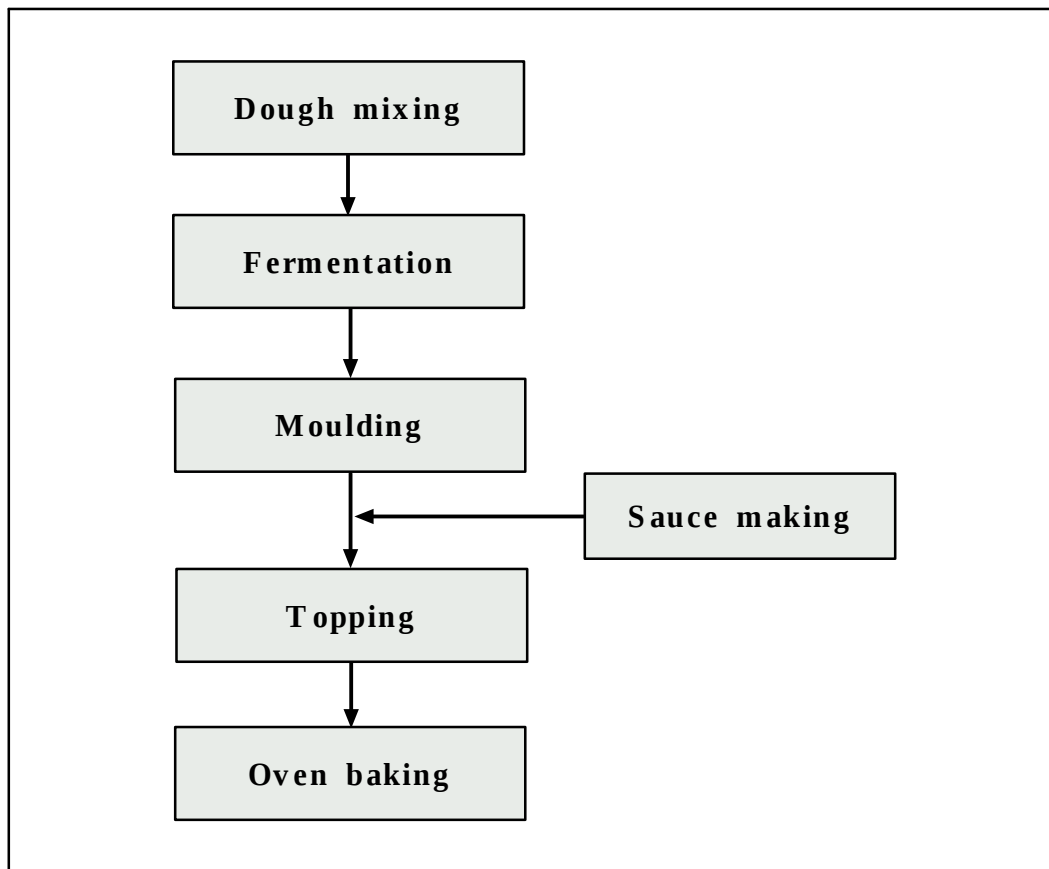
Fig. 3

. 2% , 20%

가 .



**Fig. 2. Manufacture process of *kimchi* soup**



**Fig. 3. Flow diagram of making pizza.**

2.5. 가

6 가 500 g ,  
% , , , ,

5 6 .

200 g 3 mm . 3 cm

, 가

170 180 3 .

2.6. 가

가

wheat flour 가 가

1% 가 1%, 2%, 3%

sugar, butter, yeast, yeast food, salt 가

6 1

2 . 2 가 250

g 4 3 70-80%

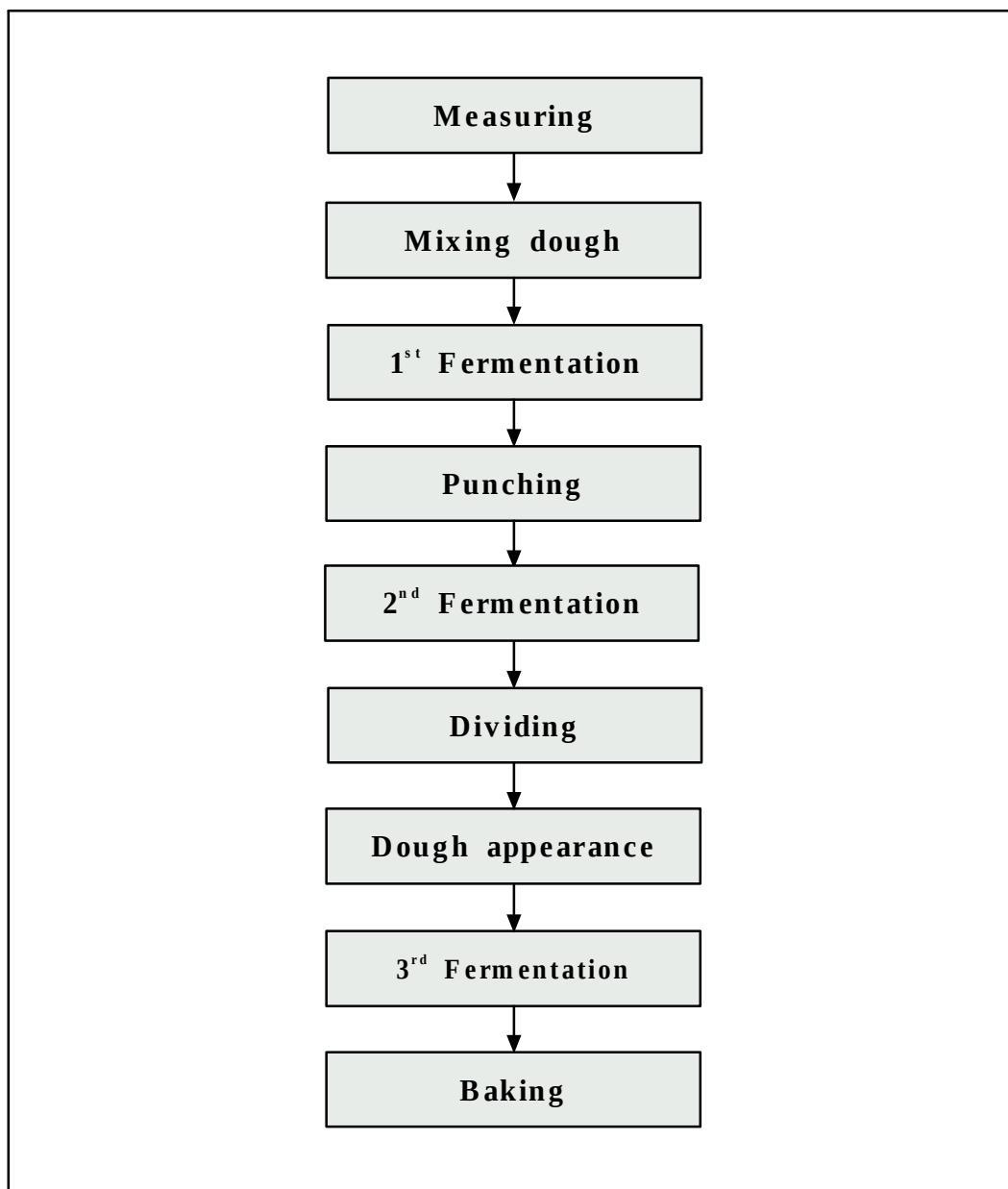
220 1 oven baking .

Fig. 4 .

가

1% 가 1%, 2%, 3% 가 , sugar, butter,  
yeast, yeast food, salt 가

.



**Fig. 4.** Diagram of processing of the *kimchi* added bread

## 2.7.

### 2.7.1.

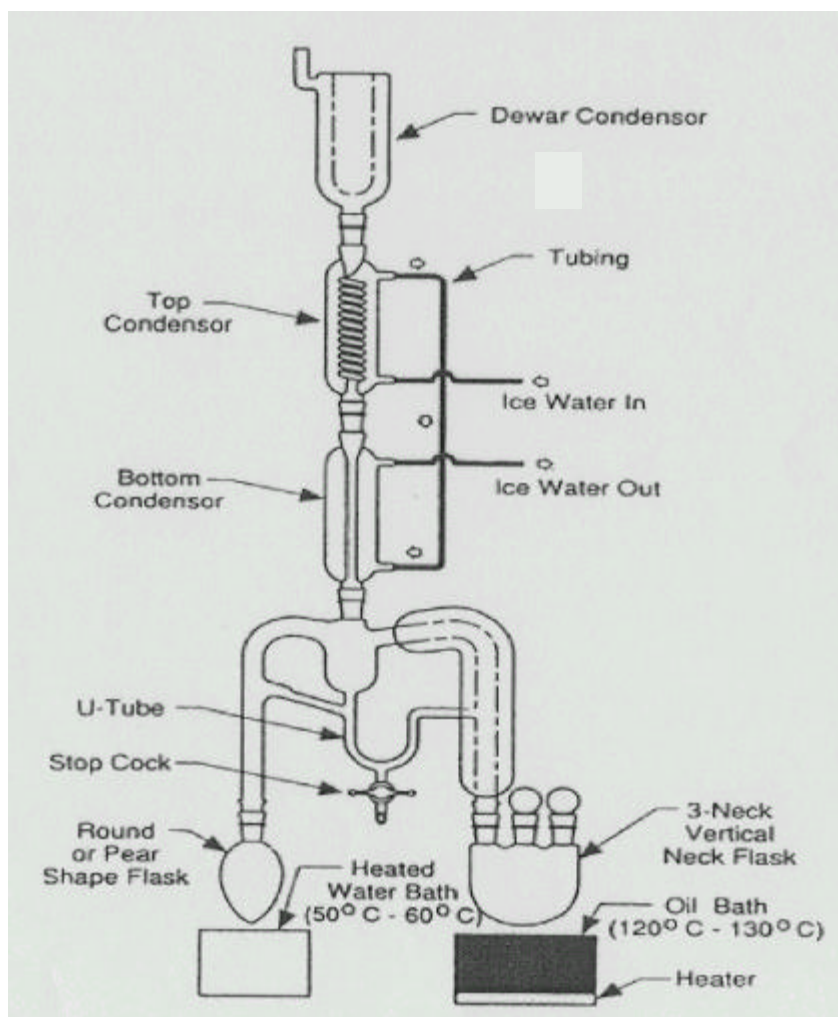
#### 2.7.1.1.

##### Likens-Nickerson

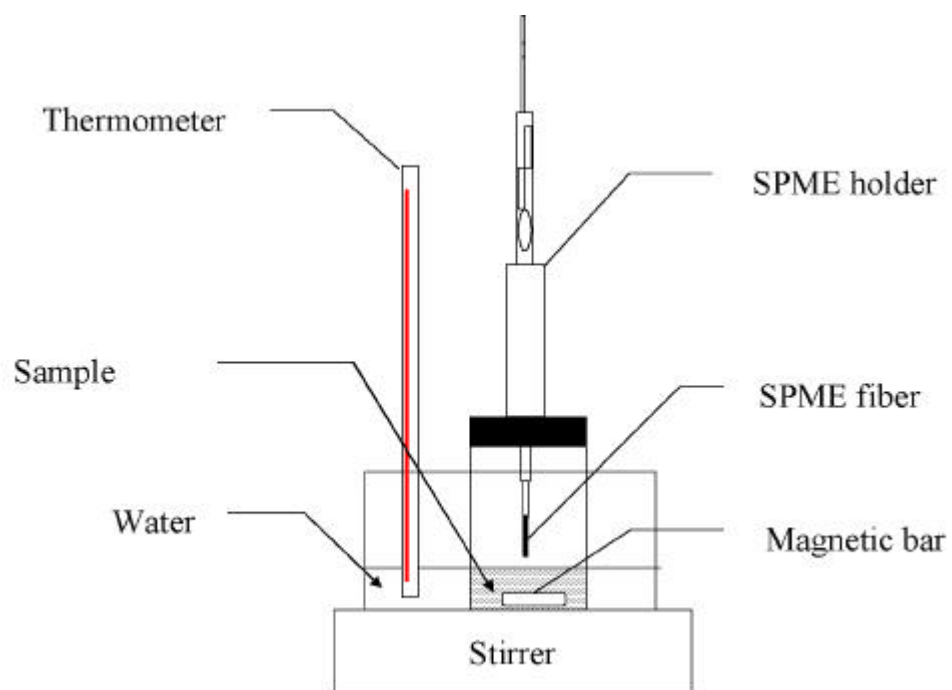
(Simultaneous steam distillation and solvent extraction apparatus, SDE, Kontes Co., USA) (Fig. 5). 200 g 200 mL (1,000 mL) heating mantle 130 가 . (100 mL) ethyl ether 50mL 50 . 3 ethyl ether가 가 . 1  $\mu$ L . gas chromatogram .

#### 2.7.1.2. SPME

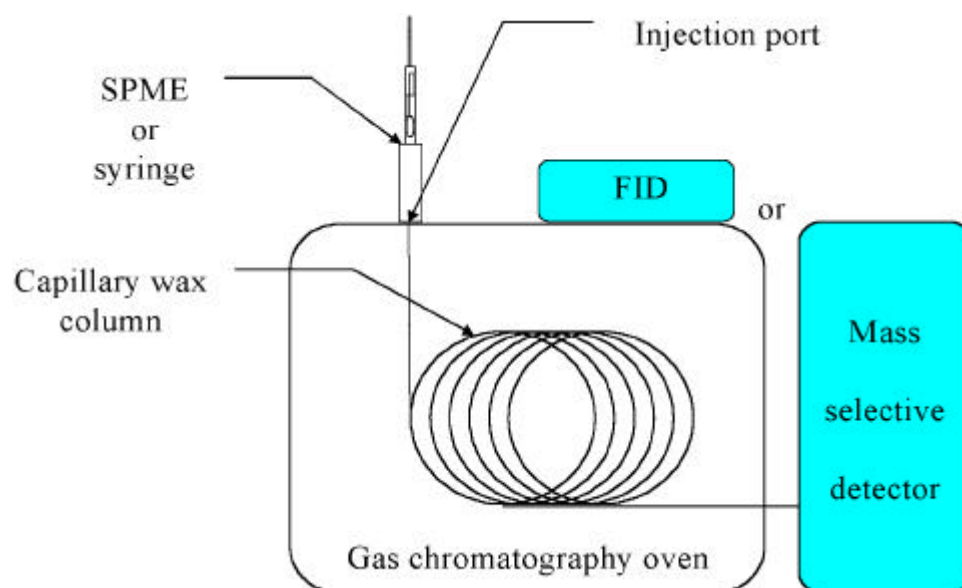
SPME(Solid phase microextraction, 100  $\mu$ m coating thickness, Supelco, USA) . 10 g 가 가 가 30 mL /min 60 , 30 . SPME fiber(57300-U, Supelco, USA) PDMS(polydimethylsiloxane) (Fig. 6). SPME fiber gas chromatography fiber (Fig. 7).



**Fig. 5. Diagram of SDE (simultaneous steam distillation & solvent extraction) system**



**Fig. 6. Diagram of SPME(solid phase microextraction) system**



**Fig. 7. Diagram of GC-FID (frame ionization detector)/MSD (mass selective detector) analysis system**

## 2.7.2.

### 2.7.2.1. GC-FID/MSD

GC (HP-5890 plus, Hewlett packard, USA)  
30 5 3 /min 가 가 200 5  
. Column HP-Innowax(30 m × 0.25 mm, I.D. ×  
0.25 μm) polar column .  
GC(gas chromatogram) GC-FID(frame ionization  
detector) MSD(mass selective detector) . GC  
(HP-5890 plus, Hewlett packard, USA) MSD(HP-5972, Hewlett packard,  
USA) column HP-Innowax(30 m × 0.25 mm × 0.25 μ  
m), He 가 (1 mL/min) split ratio 50 : 1 .  
210 solvent delay time 3 min . Mass range  
33 300 a.m.u., ionization voltage 70 eV, electron multiplier voltage  
1800 V . Mass spectrum library NBS75K.L(Wiley) .  
SDE(simultaneously steam distillation & solvent  
extraction) syringe ,  
SPME(solid phase microextraction)  
5 fiber

### 2.7.2.2. GC/ O

GCO(Gas Chromatogram Olfactometry) (SGE international 093500, Australia) . GC-FID chromatogram sniffing port chromatogram peak . 3 AEDA(aroma extract dilution analysis) 가 . flavor dilution factor  $\text{Log}^3\text{FD}(\text{FD})$  . Likens-Nickerson injector 1  $\mu\text{L}$  sniffing port 5 . 3, 3<sup>2</sup>, 3<sup>3</sup> (flavor dilution, FD) GC/Olfactometry(GCO) 가 , profile (Fig. 8).

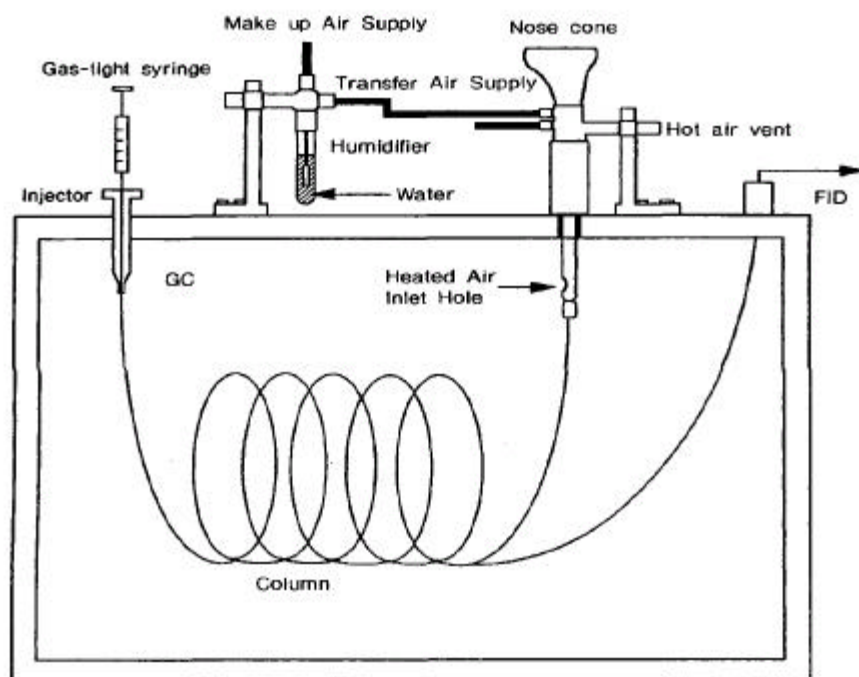


Fig. 8. Diagram of GC/O(gas chromatogram and olfactometry)

## 2.8. 가 가

### 2.8.1.

(different test) triangle test .  
(randomized sample design)  
, 가 가  
가 . 가가  
, 가  
, 10  
10 , triangle test  
, pizza  
.

### 2.8.2.

(Acceptance/preference test)  
. (ranking test)  
(randomized sample design)  
가  
, 가  
.

### 2.8.3.

(quality descriptive analysis) 3가  
(unstructure test), 가 5  
(hedonic 5 score scaling), 9 (hedonic 9 score  
scaling)  
, (flavor), (taste) (appearance)  
가  
가

### 2.9.

SAS  
Duncan's multiple comparison  
a, b grouping  
, 95%

#### 2.9.1.

pH,  
(Joo et al., 1990),  
10g 100 ml pH,  
가  
Soxhlet, Kjeldahl

. DNS , .

## 2.10.

가 , pH, , 가 가 .

### III.

#### 1.

가 가 가  
가  
pH  
가 ,  
가  
.

##### 1.1. pH

(2000) incubator(B.O.D II- 110B, Jangin  
science CO., Korea) 10 2 10 15 25  
pH Fig. 9 .  
pH 10 가 가  
가 15  
pH 4.0 4.7, 0.5 0.8%  
.  
pH .  
pH  
pH  
, (1987)

가

lactic acid succinic acid . (1987)

가 , ,

가 가

. (1990) 가

가 lactic acid acetic acid가 가 .

(1987) . (1994)

glutamic acid aspartic acid가 22.3%, 12.1%

가 .

Fig. 10 .

15

15 .

.

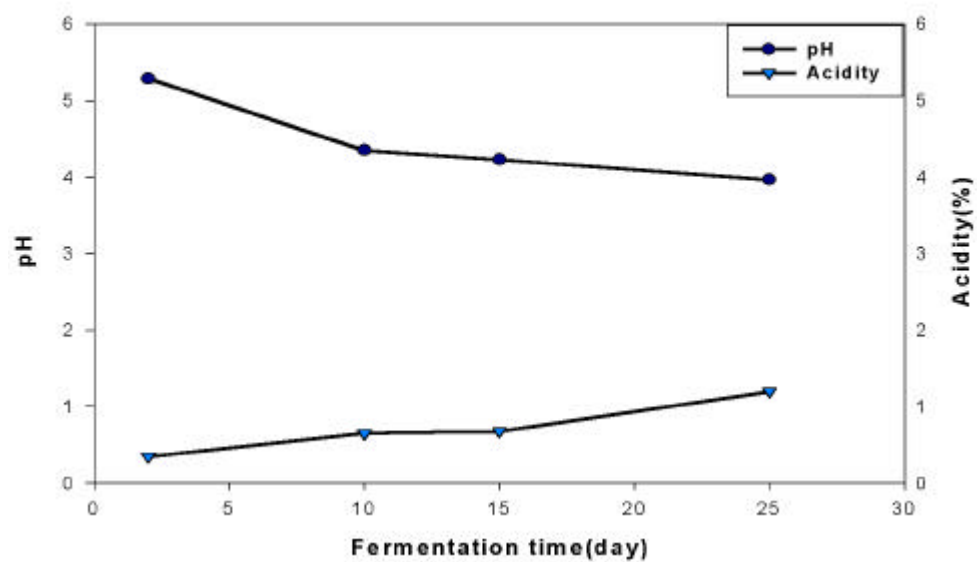
(1988) GC

mannose, fructose, glucose, galactose

, mannitol ,

.





**Fig. 9.** Change of pH and acidity of *kimchi* during storage at 10

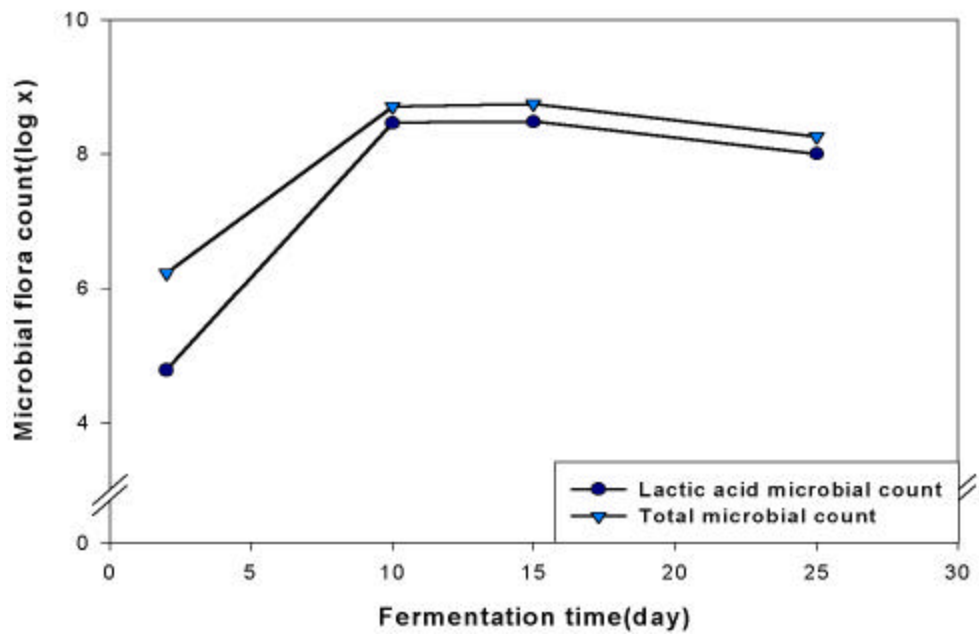
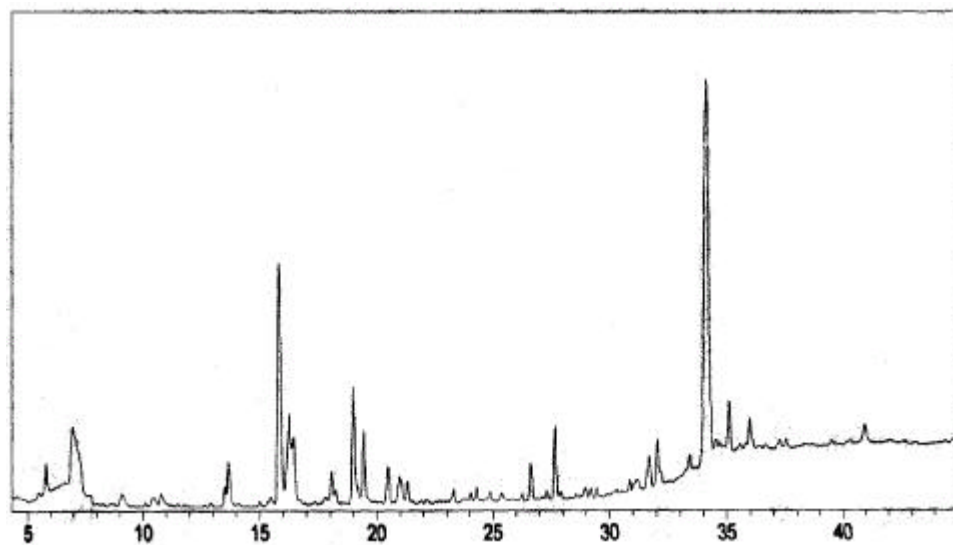


Fig. 10. Change of total or lactic acid microbial counts of *kimchi* during storage at 10



**Fig. 11. Total ion chromatogram of volatile compounds isolated from extracts of freeze-dried *kimchi* by SDE**

**Table 3. Volatile compounds isolated from extracts of  
freeze-dried *kimchi*<sup>1)</sup>**

| Compounds <sup>2)</sup>          | R T <sup>3)</sup> | Peak area <sup>4)</sup><br>( $\times 10^5$ ) |
|----------------------------------|-------------------|----------------------------------------------|
| 1-Penten-3-ol                    | 5.8               | 6.9                                          |
| 1-Octen-3-ol                     | 7.0               | 8.5                                          |
| 3-Cyclohexene-1-methanol         | 9.1               | 2.1                                          |
| Xanthosine                       | 10.5              | 0.4                                          |
| Methyl allyl disulfide           | 10.8              | 1.5                                          |
| Dimethyl trisulfide              | 13.6              | 5.4                                          |
| Acetic acid                      | 15.8              | 68.9                                         |
| 3-Furfural                       | 16.3              | 4.1                                          |
| 2-Nonyl hexanoate                | 18.1              | 1.2                                          |
| Dimethyl sulfoxide               | 19.0              | 20.4                                         |
| [2R]-3-Methyl-1,2-butanediol     | 19.4              | 6.6                                          |
| Butyric acid                     | 20.5              | 5.2                                          |
| Benzenacetaldehyde               | 21.0              | 3.0                                          |
| Allyl trisulfide                 | 24.3              | 0.8                                          |
| Acetic acid, 2-phenylethyl ester | 24.8              | 1.5                                          |
| 2-Butyl-1-octanol                | 26.2              | 0.5                                          |
| Octanoic acid                    | 29.0              | 0.6                                          |
| Hexadecanoic acid, ethyl ester   | 31.7              | 1.4                                          |
| Propyl octanoate                 | 32.1              | 1.4                                          |
| Didodecyl phthalate              | 34.1              | 20.1                                         |
| <i>cis</i> -9-Octadecen-1-ol     | 35.1              | 3.1                                          |
| Docosanoic acid                  | 39.6              | 2.0                                          |
| Eicosanol                        | 40.3              | 1.5                                          |
| Heneicosanoic acid               | 40.9              | 2.1                                          |

<sup>1)</sup> The optimum condition of *kimchi* fermentation in this study was 15days at 10 °C.

<sup>2)</sup> Compound was identified by matching our data with the references of Wiley and NIST.

<sup>3)</sup> RT means retention time(min) of gas chromatography(GC) operation.

<sup>4)</sup> Peak area was the value of GC-mass selective detector for each compound.

## 1.2.

가

GC-MSD                      TIC                      Fig. 11    Table

3                      .                      alcohol    7 , ester    5 , acid    5 ,

sulfur-containing compound    3 , aldehyde    2 , oxygen-containing    1

,    1                      24                      .                      .

Alcohol    가                      .                      ,                      1-penten-3-ol,

1-octen-3-ol, 3-cyclohexen-1-methanol, [2R]-3-methyl-1,2-butanediol, 2-butyl-1-octanol,

cis-9-octadecen-1-ol, eicosanol    7                      .

(Lee et al., 2002).

1-penten-3-ol                      1-octen-3-ol

(                      , 1992).

Ester                      2-nonyl hexanoate, 2-phenylethyl acetic acid, ethyl hexanoate,

prophyl octanoate, didodecyl phtalate    5                      2-phenylethyl

ester acetic acid                      ester

(Chang, 1967),                      Cha    (1998)

Lee    (2002)

Acid 5 acetic acid butyric acid, octanoic acid, docosanoic acid, heicosanoic acid (Kim et al., 1980), butyric acid (Freidoon, 1989), (Cha et al., 1998). (sulfur-containing compound) methyl allyl sulfide, dimethyl trisulfide, allyl trisulfide 3, allyl sulfide (Cha et al., 1998). thiocyanate (, 2000) (Cha et al., 1988 ; Hawer et al., 1988 ; Fujiwara, 1972). (1994) (1990) 4-methyl thio-3-butenyl isocyanate (MTB-ICS) , ICS dimethyl trisulfide (1988) , sulfide dimethyl disulfide, dimethyl trisulfide, dipropyl disulfide 1-isothiocyanate butane . Aldehyde 2 benzenacetaldehyde, 3-furfural . benzenacetaldehyde (Kim et al., 1980), 3-furfural

(Cha et al., 1998).

(oxygen-containing compound)

dimethyl sulfoxide가 , xanthosine

(Cha et al., 1998).

, allyl sulfide aldehyde, alcohol

, alcohol ester

(Cha et al., 1993 ; Cho et al., 1988

; Jain, 1977).

,

가

가(

가)

.

Cha (1998)

,

.

(Koh et al., 1993).

## 2. 가

(Simultaneous steam distillation and solvent extraction ; SDE) headspace

SPME(Solid phase microextraction) .

GCO(Gas chromatography & olfactometry)

.

### 2.1.

SDE capillary HP-Innowax  
GC-MSD . total ion  
chromatogram Fig. 13 , Table 8 .  
23 . , aldehydes  
가 5 가 , alcohols 4 , acids가 4 , 3 , ketone 1  
, 6 .  
eugenol 가 , dodecanoic  
acid, 2,4-decadienal, acetic acid, methyl 2-propenyldisulfide, hexanal, 2-pentylfuran  
. aldehydes 2,4-decadienal 가  
, alcohols eugenol , sulfide methyl 2-propenyl disulfide  
가 .  
alcohol 가 43.88% 가  
. , eugenol 39.40% 가  
. Eugenol clover  
, ,

( , 2001). Clover

가 , eugenol  
 . Ketone 12.12% ,  
aldehyde 가 5.56% , acid 8.90%  
 , sulfur-containing 2.43% .

## 2.2. SPME

SPME total ion  
chromatogram(TIC) Fig. 14 , GC-MSD Table 5

. alcohol 가 7 , ester 가 5  
aldehyde , acid , sulfur-containing , furan , terpene 가 1  
17 . eugenol 가

,  
acetic acid가 , alcohol  
*p* - cymen-8-ol eugenol acetic acid  
( , 1985).

가 aldehyde  
(Fereidoon, 1989), 가

(Kim et al., 1998; , 1991; , 1989). Ester 가 5  
butter

. 가

sulfur-containing compound 가  
(Kim, 1997). Furan 2-pentylfuran furan  
2-furan methanol Maillard  
가 가 ( , 2000).  
(retention time) 14 24  
, Cha (1998)  
.  
37  
.



5 %



10 %

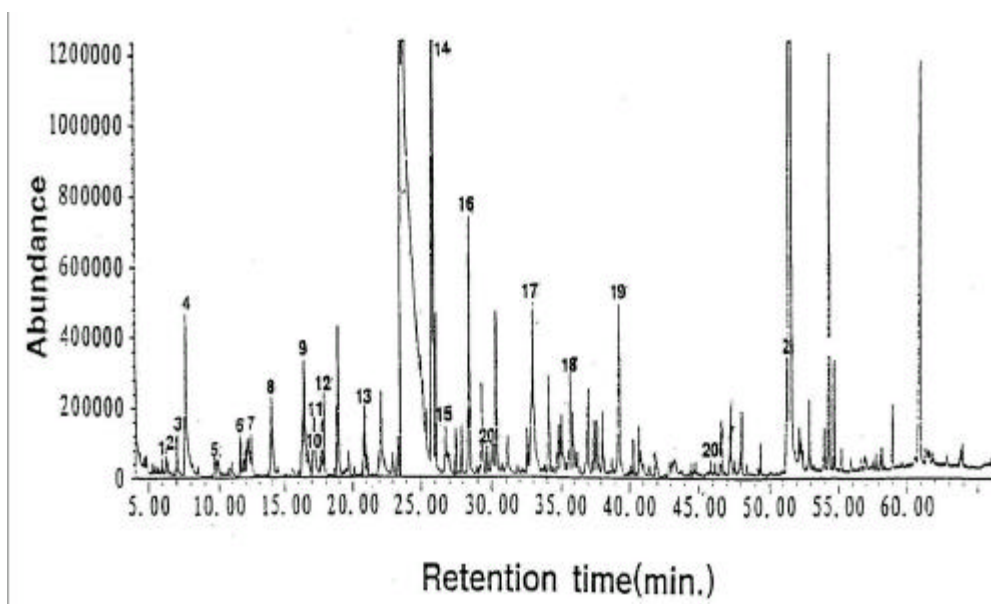


15 %



20 %

**Fig. 12. Products of *kimchi* sauces made by adding several percents of *kimchi* powder**



**Fig. 13. Total ion chromatogram of volatile compounds extracted from *kimchi* sauce with SDE<sup>1)</sup>**

<sup>1)</sup>SDE(simultaneously steam distillation & solvent extraction)

**Table 4. Identified volatile compounds extracted from *kimchi* sauce with SDE**

| Peak No. | Compounds                   | RI   | Peak area (%) | Peak area (%) | FD factor            | Odor description           |
|----------|-----------------------------|------|---------------|---------------|----------------------|----------------------------|
| 1        | 2-Butanol                   | 1032 | 2.23          | 0.13          | 243(3 <sup>5</sup> ) | vinous                     |
| 2        | Champene                    | 1040 | 2.62          | 0.15          | 3(3 <sup>1</sup> )   | camphor                    |
| 3        | Dimethyl disulfide          | 1058 | 4.04          | 0.24          | 27(3 <sup>3</sup> )  | onion                      |
| 4        | Hexanal                     | 1074 | 25.84         | 1.51          | - <sup>1)</sup>      | cut grass <sup>R)</sup>    |
| 5        | p-Xylene                    | 1120 | 2.23          | 0.13          | 3(3 <sup>1</sup> )   | geranium                   |
| 6        | 2-Methyl-1-butanol          | 1162 | 6.46          | 0.38          | -                    | whiskey <sup>R)</sup>      |
| 7        | Cineole                     | 1180 | 7.85          | 0.46          | -                    | peppermint <sup>R)</sup>   |
| 8        | 2-Pentylfuran               | 1214 | 20.27         | 1.18          | 81(3 <sup>4</sup> )  | sweet fruity <sup>R)</sup> |
| 9        | Methyl-2-propenyl disulfide | 1265 | 25.98         | 1.52          | 81(3 <sup>4</sup> )  | garlic                     |
| 10       | Octanal                     | 1279 | 8.26          | 0.48          | 3(3 <sup>1</sup> )   | soapy                      |
| 11       | 3-Hydroxy-2-butanone        | 1295 | 12.90         | 0.75          | -                    | buttery <sup>R)</sup>      |
| 12       | Dimethyl trisulfide         | 1357 | 11.48         | 0.67          | 3(3 <sup>1</sup> )   | garlic                     |
| 13       | Acetic acid                 | 1416 | 29.16         | 1.70          | 27(3 <sup>3</sup> )  | sour                       |
| 14       | (E,E)-2,4-Heptadienal       | 1491 | 7.97          | 0.47          | 3(3 <sup>1</sup> )   | nutty                      |
| 15       | Benzaldehyde                | 1518 | 7.69          | 0.45          | 3(3 <sup>1</sup> )   | almond                     |
| 16       | 1-Octanol                   | 1561 | 4.85          | 0.28          | 3(3 <sup>1</sup> )   | chemical                   |
| 17       | 2-Furan methanol            | 1668 | 11.87         | 0.69          | 81(3 <sup>4</sup> )  | fresh                      |
| 18       | (E,E)-2,4-Decadienal        | 1809 | 30.82         | 1.80          | 9(3 <sup>2</sup> )   | fried                      |
| 19       | Eicosane                    | 2000 | 2.38          | 0.14          | 27(3 <sup>3</sup> )  | alkane                     |
| 20       | Octanoic acid               | 2057 | 8.06          | 0.47          | -                    | sweety <sup>R)</sup>       |
| 21       | Eugenol                     | 2122 | 673.99        | 39.40         | -                    | clover <sup>R)</sup>       |
| 22       | Decanoic acid               | 2251 | 14.53         | 0.85          | -                    | rancid <sup>R)</sup>       |
| 23       | Dodecanoic acid             | 2432 | 83.94         | 4.91          | -                    | waxy <sup>R)</sup>         |

<sup>1)</sup>- means not detected in olfactometry

<sup>R)</sup> means of value on Kovat's RI.

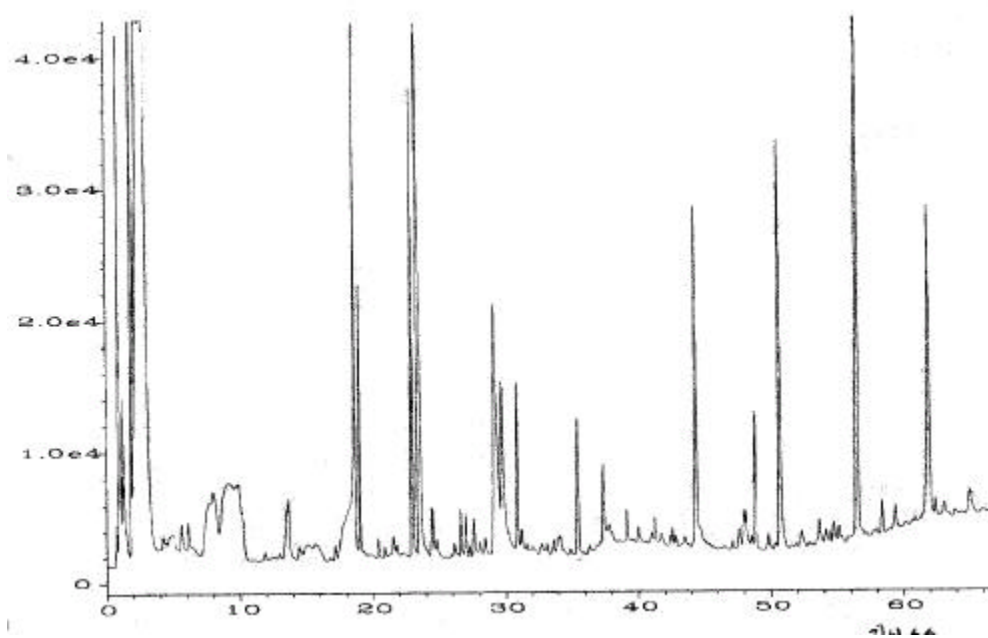


Fig. 14. Total ion chromatogram of volatile compounds isolated from extracts of *kimchi* sauce with SPME (solid phase microextraction)

**Table 5. Volatile compounds identified from extracts of *kimchi* sauce with SPME**

| <b>Compounds</b>             | <b>R T <sup>1)</sup></b> | <b>Peak area <sup>2)</sup><br/>( × 10<sup>5</sup> )</b> |
|------------------------------|--------------------------|---------------------------------------------------------|
| Ethanol                      | 5.3                      | 7.1                                                     |
| <i>p</i> - Cymene            | 10.4                     | 2.3                                                     |
| Dimethyl disulfide           | 14.0                     | 4.5                                                     |
| 2- Pentylfuran               | 17.8                     | 5.3                                                     |
| Acetic acid                  | 18.3                     | 18.3                                                    |
| 2- Pentanol                  | 22.4                     | 7.7                                                     |
| 2- Nonanol                   | 24.1                     | 5.6                                                     |
| Heptanoic acid               | 26.2                     | 1.9                                                     |
| 3,3- Difluoroallyl hexanoate | 27.2                     | 1.4                                                     |
| 5- Ethyl- 2- heptanol        | 30.7                     | 1.6                                                     |
| 2- Furan methanol            | 31.8                     | 7.8                                                     |
| Decanoic acid                | 34.9                     | 2.0                                                     |
| [Z]- 2- Nonanal              | 37.1                     | 1.8                                                     |
| Eugenol                      | 39.3                     | 40.5                                                    |
| Dodecanoic acid              | 42.6                     | 4.4                                                     |
| <i>p</i> - Cymen- 8- ol      | 46.6                     | 1.7                                                     |
| Undecanoic acid              | 49.7                     | 6.4                                                     |

<sup>1)</sup> RT means retention time(min) of gas chromatography(GC) operation.

<sup>2)</sup> Peak area was the value of GC-mass selective detector for each compound.

### 2.3. GCO

### sniffing test

SDE

(flavor dilution, FD) 가 GCO 5 panel test

Fig. 15 Table 4 .

Fig. 15

RI 700 2000

peak 40 . TIC(total ion chromatogram)

peak 60 가 , 25

peak olfactory sniffing test

. FD factor 3 6

peak 2 , 5 peak 4 RI

1032 vinous . 3 4

peak 5 , 3 peak 13 FD factor

가 . Table 4 RI 1040

camphor, 1058 , 1074 , 1120 geranium,

1162 . 1279

soapy , 1295 buttery, 1357

. 1491 nutty , 1518 almond

. 1561 가 , 1809

가 , 2000 alkane( ) .

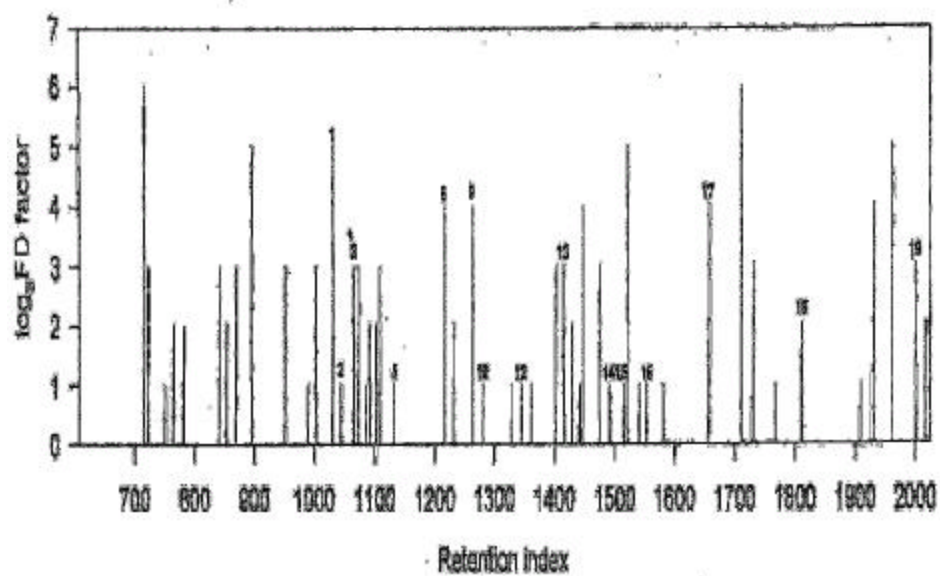
RI 2000 , 2057

, 2122 clover eugenol

. 2251 , 2432 .

Fig. 15 hexanal eucalyptol peak가 sniffing test

. 2-pentylfuran methyl-2-propenyl disulfide  
 peak FDC(flavor dilution chromatogram) 4  
 . Fig. 15 peak olfactory  
 , peak  
 olfactory .  
 Cha (1998) Choi (1997) aldehydes sweet candy  
 , acids 가 , sulfides  
 , pentene octene mushroom earthy  
 .  
 가 가 , , ,  
 Fig. 16 .



**Fig. 15. Flavor dilution chromatogram of volatile compounds  
isolated from extracts of *kimchi* sauce with SDE<sup>1)</sup>**

<sup>1)</sup>SDE(simultaneously steam distillation & solvent extraction)



Fig. 16. Product of application of *kimchi* sauce for various meat food

### 3. 가

가 .  
가 (SDE)  
headspace SPME .

#### 3.1.

(Acree, et al., 1993)  
TIC(total ion chromatogram) Fig. 17 , Table 6  
. Alcohol 11 , ester 5 , aldehyde 4 , terpene 3 ,  
sulfur-containing 1 , 3 27 .  
pyrazine pyrimidine  
(nutty flavor) 가 , aldehyde  
가 (Cha et al., 1988 ; , 1996 ; , 1994).  
가 .  
3-penten-3-ol (fresh flavor)  
3,7-dimethyl-7-octen-1-ol 가  
(Lee et al., 1984 ; , 1991),  
acetic acid  
. (garlic flavor) , allyl trisulfide  
allyl triheptanoate (Jain, 1977), sulfur  
allyl trisulfide .  
terpene 3  
. limonene

alcohol (more mild flavor)  
 가 (Lee et al, 1998). terpene alcohol L-menthol  
 (fresh flavor or green aroma)  
 (Jung, 2002), (sour taste)

### 3.2. SPME

headspace SPME  
 Fig. 18 , Table 7  
 ester 6 , alcohol 4 , aldehyde 3 , sulfur-containing  
 3 , terpene 1 , acid 1 , 2 20  
 . 가 3-penten-2-ol

SDE  
 acetic acid (Lee et al., 1998).  
 (retention time) 30 ester 가  
 가 , SPME ester  
 가 (Lee et al, 2002).  
 Nonanoic acid decanoic acid (green aroma)  
 (Lee et al., 1998).

### 3.3.

가

가

(difference test)

(ranking test)

가 (control)

10%, 20%, 30% 가 4가

Fig. 19

,

20%

가

가

10% 가 ,

가

, 30%

가

가

. 20

가

5

15

.

(acceptance/preference test)

(overall)

가

가

.

(unstructured test)

Fig. 19

.

가 20%

가

Fig. 20

.

.

가

가

.

,

,

,

,

.

가

가

.

30%

가

가가

.

(texture)

가

,

,

,

,

99%

.

20%

.

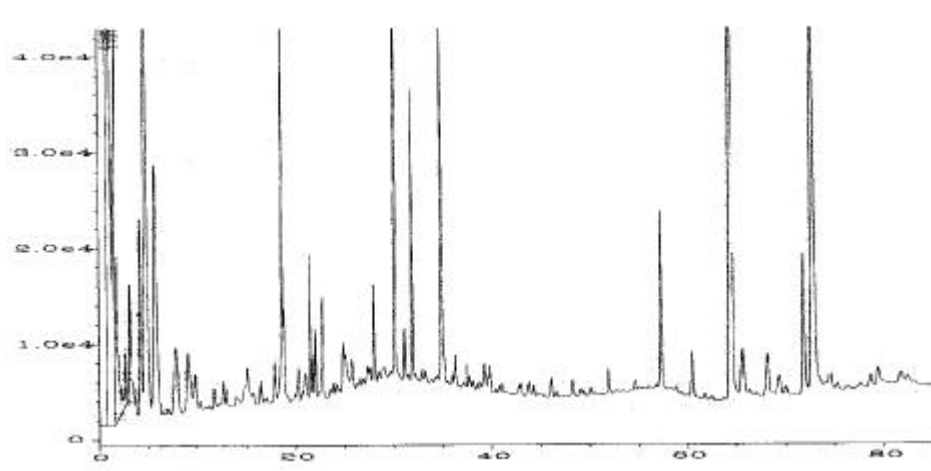
**Table 6. Volatile compounds identified from extracts of *kimchi* soup  
with SDE<sup>1)</sup>**

| <b>Compounds</b>            | <b>R T<sup>2)</sup></b> | <b>Peak area<sup>3)</sup><br/>(<math>\times 10^5</math>)</b> |
|-----------------------------|-------------------------|--------------------------------------------------------------|
| 3-Penten-3-ol               | 6.6                     | 37.3                                                         |
| 3-Methyl-2-pentene          | 7.9                     | 35.9                                                         |
| Limonene                    | 8.8                     | 29.5                                                         |
| Terpinolene                 | 10.0                    | 7.2                                                          |
| <i>p</i> -Cymene            | 10.8                    | 20.9                                                         |
| 3,7-Dimethyl-7-octen-1-ol   | 12.9                    | 1.4                                                          |
| Nonanal                     | 14.2                    | 8.0                                                          |
| E-2-Decenal                 | 15.3                    | 1.6                                                          |
| Allyl heptanoate            | 16.7                    | 16.2                                                         |
| Isooctanol                  | 18.2                    | 3.4                                                          |
| 2-Butyl-1-octanol           | 19.6                    | 10.7                                                         |
| Geranial diethyl acetal     | 20.4                    | 44.6                                                         |
| Allyl <i>n</i> -butyl ether | 21.0                    | 3.1                                                          |
| 2-Methylundecyl-2-thiol     | 22.1                    | 4.4                                                          |
| 1,8-Cineole                 | 23.3                    | 15.6                                                         |
| Allyl trisulfide            | 24.4                    | 43.3                                                         |
| L-Menthol                   | 25.5                    | 4.2                                                          |
| 9-Octadecenal               | 28.9                    | 4.7                                                          |
| 2-Butyl-1-octanol           | 29.4                    | 4.8                                                          |
| 6-Methyl octadecane         | 30.8                    | 6.4                                                          |
| 2-Ethyl decanol             | 31.6                    | 2.2                                                          |
| Methyl-2-oxooctadecanoate   | 33.4                    | 2.3                                                          |
| Dioctyl phthalate           | 34.0                    | 6.7                                                          |
| 2-Ethyl-1-decanol           | 34.6                    | 6.4                                                          |
| 2-Methyl-1-dodecanol        | 35.8                    | 4.0                                                          |
| Heneicosanoic acid          | 37.2                    | 2.7                                                          |
| Docosanoic acid             | 40.9                    | 3.5                                                          |

<sup>1)</sup>SDE : Simultaneous steam distillation and solvent extraction

<sup>2)</sup> RT means retention time(min) of gas chromatography(GC) operation.

<sup>3)</sup> Peak area was the value of GC-mass selective detector for each compound.



**Fig. 17. Total ion chromatogram of volatile compounds isolated from extracts of *kimchi* soup with SDE**

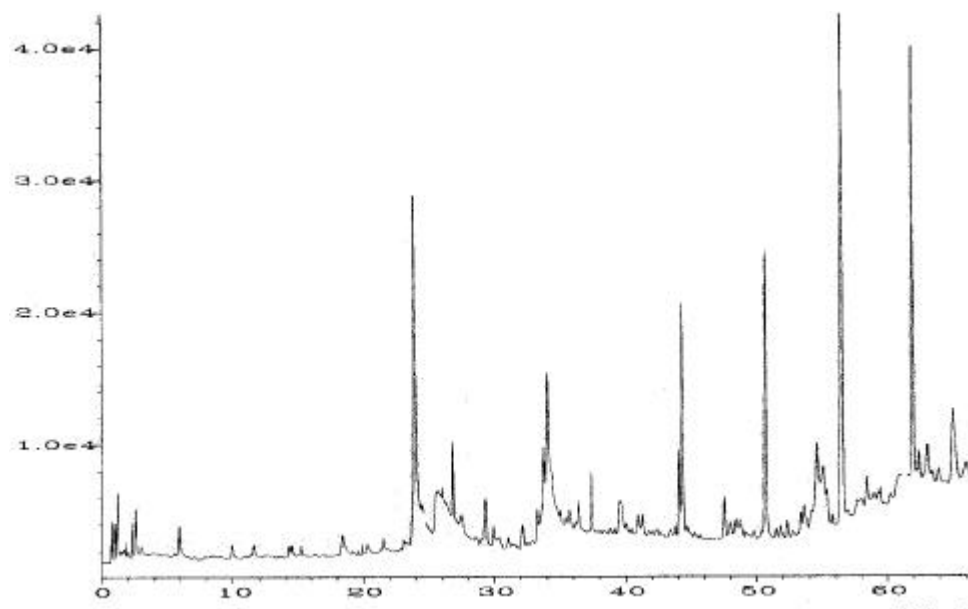
**Table 7. Volatile compounds identified from extracts of *kimchi* soup  
with SPME<sup>1)</sup>**

| <b>Compounds</b>                | <b>R T<sup>2)</sup></b> | <b>Peak area<sup>3)</sup><br/>(<math>\times 10^5</math>)</b> |
|---------------------------------|-------------------------|--------------------------------------------------------------|
| 3-Penten-2-ol                   | 6.5                     | 21.8                                                         |
| 2-Prophanamine                  | 7.8                     | 5.4                                                          |
| Limonene                        | 8.8                     | 9.5                                                          |
| Nonanal                         | 14.5                    | 0.4                                                          |
| Acetic acid                     | 15.9                    | 4.5                                                          |
| Isooctanol                      | 16.2                    | 0.9                                                          |
| 1-Allyloxy-2-propanol           | 16.9                    | 0.6                                                          |
| 1-Buten-3-ynylethylsulfide      | 19.6                    | 0.3                                                          |
| Allyl trisulfide                | 21.8                    | 2.0                                                          |
| Octanal                         | 22.8                    | 0.3                                                          |
| Hexanoic acid                   | 24.9                    | 1.2                                                          |
| Decenal                         | 26.9                    | 0.3                                                          |
| Cytidine                        | 29.0                    | 0.6                                                          |
| Nonanoic acid                   | 30.4                    | 4.1                                                          |
| Decanoic acid                   | 32.6                    | 4.5                                                          |
| 2-Nonyl hexanoate               | 36.3                    | 1.2                                                          |
| Methyl 14-methyl-pentadecanoate | 37.7                    | 0.9                                                          |
| Octadecanoic acid               | 39.7                    | 4.6                                                          |
| Octyl vinyl sulfide             | 41.8                    | 0.7                                                          |
| 2-Hexadecanol                   | 44.7                    | 1.0                                                          |

<sup>1)</sup> SPME : solid phase microextraction

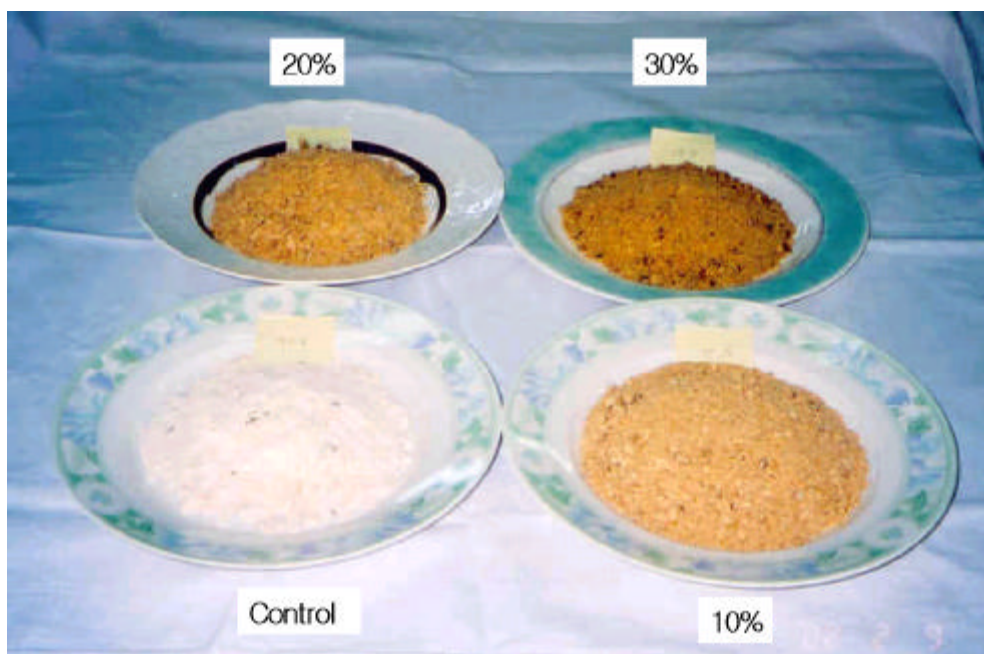
<sup>2)</sup> RT means retention time(min) of gas chromatography(GC) operation.

<sup>3)</sup> Peak area was the value of GC-mass selective detector for each compound.

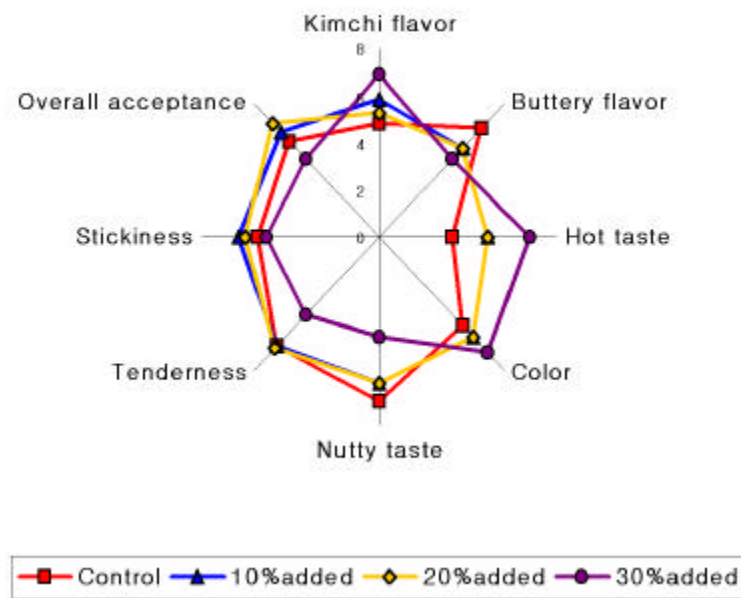


**Fig. 18. Total ion chromatogram of volatile compounds extracted from *kimchi* soup with SPME<sup>1)</sup>**

<sup>1)</sup> SPME : solid phase microextraction



**Fig. 19. Products of *kimchi* soup powder made by adding *kimchi* powder of several percents**



**Fig. 20. Quality description analysis on sensory quality of *kimchi* soup for adding several percents of *kimchi* powder**

#### 4. 가

##### 4.1. 가

##### 4.1.1. 가

10%, 20% 30% 가 , ,

Table 8 .

20% 가

가 20% 가가 가

. 20% 가 가 가

, 10% 가 가

가 .

. 20%

가 가 가 가

. 30% 가

가 가 .

#### 4.1.2. 가

2% ,  
 20% 가  
 Table 9 .  
 2% 20% 가  
 , , 가 가 .  
 가 가  
 . 가  
 가 가  
 , 가  
 가 .

#### 4.2. 가

가 가  
 triangle test 가  
 Fig. 21 ,  
 Table 10 Table 11 .  
 Table 11 2% 가  
 $P < 0.05$   $P < 0.001$   
 . 6% 7  
 가 .  
 가 2% 4%

6% 6% 8% , Table 12  
 . 4% 6%  $P < 0.05$  , 6% 8%  
 $P < 0.001$  , 가 2%

Fig. 22 .

가  
 가 가 4%,  
 6%, 8% .  
 가 ,  
 ( , 1985). 가 가  
 4% 6%, 8%  
 가  
 가  
 . 6% 가  
 , 8% 가  
 가

(butter) (hot), (saltiness), (sweetness),  
 가 . Fig. 23  
 가 가 4%

, 6%, 8%      sweet      . 6%  
4%      . 8%  
,  
,  
6%      가      .

**Table 8. Sensory evaluation of pizza sauce added with *kimchi* at several levels**

| <b>Treatment \ Quality</b> | <b>Flavor</b>      | <b>Taste</b>     | <b>Color</b>       | <b>Overall acceptability</b> |
|----------------------------|--------------------|------------------|--------------------|------------------------------|
| Control                    | 3.6 <sup>b*</sup>  | 4.1 <sup>a</sup> | 3.5 <sup>b</sup>   | 3.7 <sup>b,c</sup>           |
| 10%                        | 3.9 <sup>b</sup>   | 4.5 <sup>a</sup> | 3.9 <sup>a,b</sup> | 4.1 <sup>a,b</sup>           |
| 20%                        | 4.5 <sup>a,b</sup> | 4.6 <sup>a</sup> | 4.4 <sup>a</sup>   | 4.4 <sup>a</sup>             |
| 30%                        | 3.8 <sup>b</sup>   | 3.2 <sup>b</sup> | 3.4 <sup>b</sup>   | 3.4 <sup>c</sup>             |

Scale : excellent = 5, very good = 4, good = 3, bad = 2, very bad =1

\* Means with different letters within same columns are significantly different (P<0.05).

**Table 9. Sensory evaluation of pizza added with *kimchi* at 20% levels**

| <b>Treatment \ Quality</b> | <b>Flavor</b>      | <b>Taste</b>       | <b>Color</b>       | <b>Overall acceptability</b> |
|----------------------------|--------------------|--------------------|--------------------|------------------------------|
| Control                    | 3.3 <sup>b**</sup> | 3.7 <sup>a,b</sup> | 3.4 <sup>b</sup>   | 3.5 <sup>b</sup>             |
| A                          | 3.5 <sup>a,b</sup> | 3.2 <sup>b</sup>   | 3.6 <sup>a,b</sup> | 3.5 <sup>b</sup>             |
| B                          | 4.0 <sup>a</sup>   | 4.0 <sup>a</sup>   | 4.2 <sup>a</sup>   | 4.1 <sup>a</sup>             |

Scale : excellent = 5, very good = 4, good = 3, bad = 2, very bad = 1

\* A: Pizza with 20% *kimchi* sauce; B: Pizza which dough was mixed with 2% *kimchi* powder and pizza sauce was

\*\* Means with different letters within same columns are significantly different (P<0.05).

**Table 10. Sensory evaluation of *kimchi* cracker by triangle test**

| Samples <sup>1)</sup> | Observed value <sup>2)</sup> | Significant value |
|-----------------------|------------------------------|-------------------|
| A                     | 5                            | P<0.05            |
| B                     | 6                            | P<0.001           |

<sup>1)</sup> “ A ” was tested between 4% and 6%, “ B ” was between 6% and 8%

<sup>2)</sup> The number of answers was the corrected one among 7 panels in triangle test

**Table 11. Sensory evaluation of *kimchi* cracker by ranking test**

| <b>Samples<sup>1)</sup></b> | <b>A</b>            | <b>B</b>          | <b>C</b>          | <b>D</b>          | <b>E</b>          |
|-----------------------------|---------------------|-------------------|-------------------|-------------------|-------------------|
| <b>Characters</b>           |                     |                   |                   |                   |                   |
| Color                       | 2.8 <sup>bc2)</sup> | 2.4 <sup>c</sup>  | 1.9 <sup>c</sup>  | 4.2 <sup>a</sup>  | 3.8 <sup>ab</sup> |
| Flavor                      | 3.9 <sup>a</sup>    | 2.9 <sup>ab</sup> | 2.2 <sup>b</sup>  | 2.2 <sup>b</sup>  | 3.8 <sup>a</sup>  |
| Taste                       | 4.3 <sup>a</sup>    | 1.8 <sup>c</sup>  | 3.2 <sup>ab</sup> | 2.8 <sup>bc</sup> | 2.9 <sup>bc</sup> |
| Overall acceptance          | 4.2 <sup>a</sup>    | 1.9 <sup>b</sup>  | 2.8 <sup>b</sup>  | 2.9 <sup>b</sup>  | 3.2 <sup>ab</sup> |

<sup>1)</sup> “A ” was made by added with 2% *kimchi* powder. “B ” is 4%, “C ” is 6%, “D ” is 8% and “E ” is 10%.

<sup>2)</sup> Means with the same alphabets are not significantly different by Duncan's multiple range test ( $P < 0.05$ ).



**Control**



**2 %**



**4 %**



**6 %**

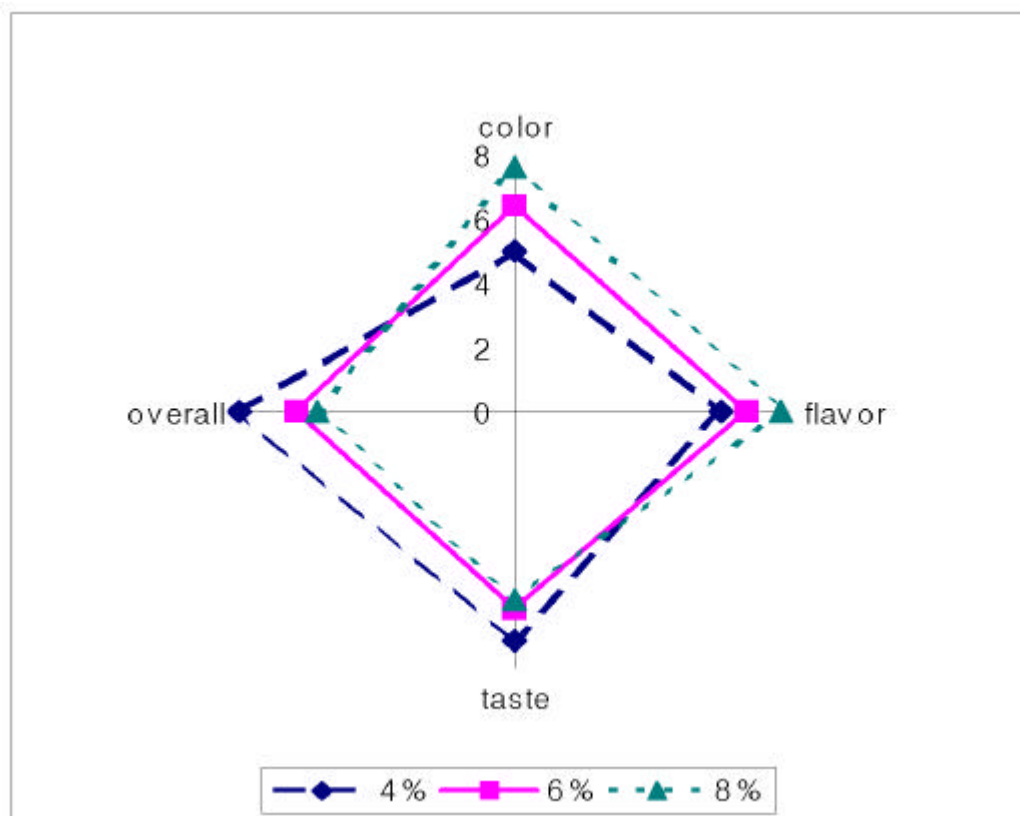


**8 %**

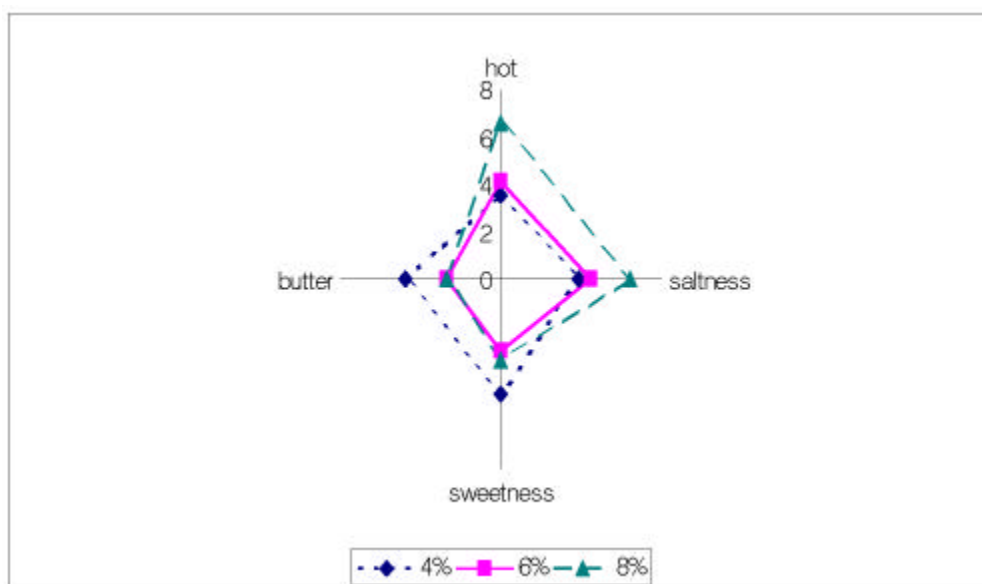


**10 %**

**Fig. 21. Products of *kimchi* crackers made by adding *kimchi* powder of several percents**



**Fig. 22. Quality description analysis profile of *kimchi* crackers by preference test**



**Fig. 23. Quality description analysis profile of *kimchi* crackers by hedonic test**

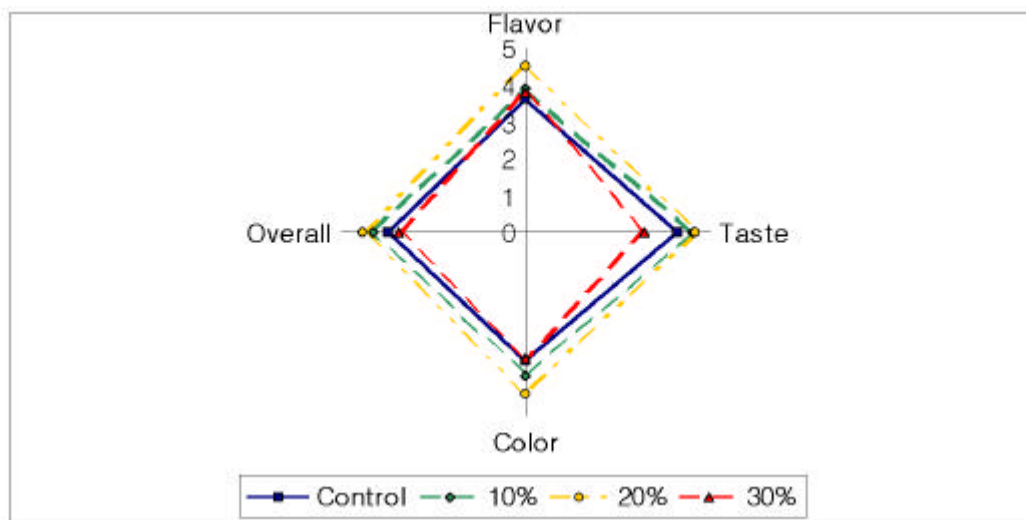


Fig. 24. Quality description analysis profile of *kimchi* powder-added pizza sauce

4.3.

가

1%, 2%

3%

가

Table 12

.

1%, 2%

3%

가

가

가

.

3%

가

가가

.

2%

가

가

.

**Table 12. Sensory evaluation of bread made by adding 1%, 2% and 3% *kimchi* powders**

| <b>Sample</b> | <b>Flavor</b>      | <b>Color</b>     | <b>Taste</b>       |
|---------------|--------------------|------------------|--------------------|
| Control       | 3.8 <sup>a</sup>   | 3.9 <sup>a</sup> | 3.1 <sup>a b</sup> |
| 1%            | 3.1 <sup>a b</sup> | 3.8 <sup>a</sup> | 3.4 <sup>a b</sup> |
| 2%            | 3.3 <sup>b</sup>   | 4.1 <sup>a</sup> | 3.8 <sup>a</sup>   |
| 3%            | 2.7 <sup>c</sup>   | 2.8 <sup>b</sup> | 2.9 <sup>b</sup>   |

a,b,c Means of the different letters within the same column are significantly different ( $P < 0.05$ ).

4.4. 가

4.4.1. 가

가 가

Table 13

.

가

.

10.7%

1.7%

1.7%

.

가

( , 1998).

가

1.7%

가

가

가

pH

.

4.6,

0.73%

,

pH

4.7,

0.78%

.

가

,

가

.

4.5. 가

가

가

가

. , , pH, ,

가

가

.

#### 4.5.1.

Fig. 25 .

가

2%, 3% 가

가

1% 가

3,150 Mℓ

1% 가 5% 가 , 2% 3% 가 3200 Mℓ

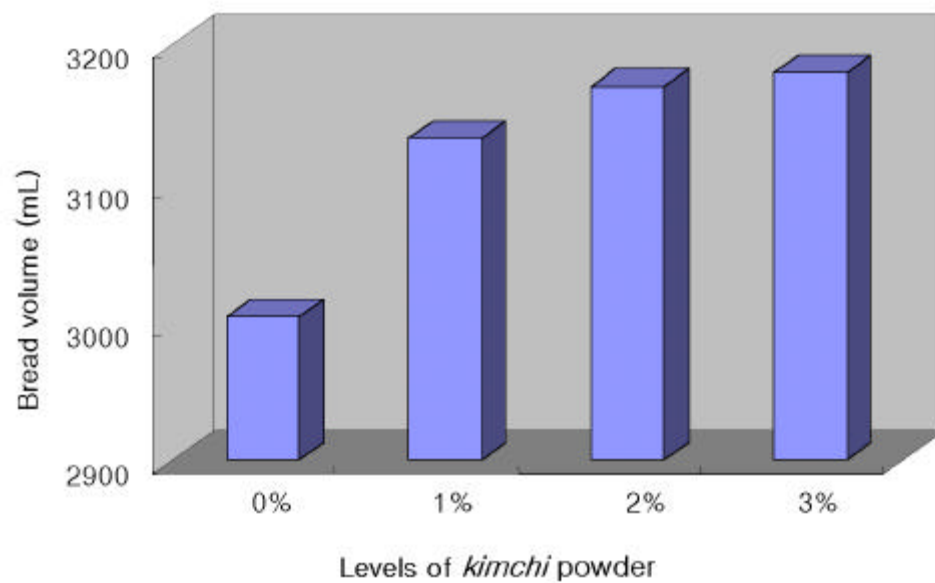
6.6% 가

3,000 Mℓ 가

.

**Table 13. Approximate chemical composition of *kimchi* pizza sauce and pizza sauce**

| (unit:%)       |                           |             |
|----------------|---------------------------|-------------|
| Composition    | Sample                    |             |
|                | <i>Kimchi</i> pizza sauce | Pizza sauce |
| Moisture       | 21.6                      | 21.5        |
| Crude protein  | 12.4                      | 10.7        |
| Crude fat      | 5.2                       | 6.9         |
| Reducing sugar | 8.3                       | 6.6         |
| Salt           | 2.1                       | 1.8         |



**Fig. 25. Volume of fresh bread containing 0%, 1%, 2% and 3% *kimchi* powder.**

#### 4.5.2. pH

가 가 20g  
(homogenization) pH  
Fig. 26 . pH pH가 5.30 1%  
가 pH 5.35 2% 가 pH 5.45, 3% 가 pH 5.55  
, pH 2 , 4  
6 pH 가 ( , 1996).

#### 4.5.3. (hardness)

가 25  
가 가 2 , 4 ,  
6 Fig. 27 . 가 가  
가 가 100 g 200 g 가 2  
1% 2% 가 200 g  
400 g 가 가, 가 4  
6 900 g 가 500 g  
. 가  
( , 1999).

#### 4.5.4.

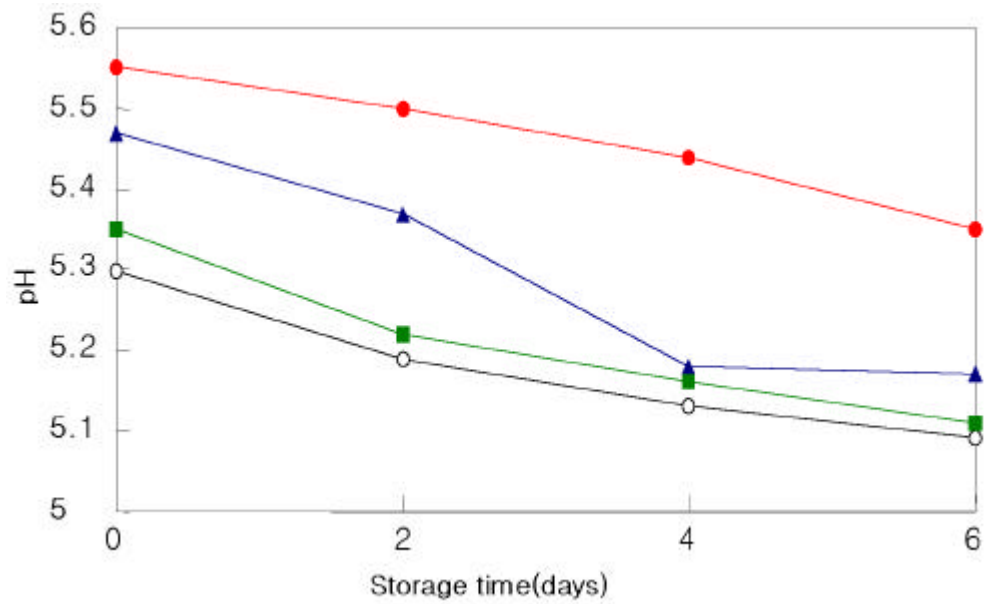
Fig. 28 .

가

가 4

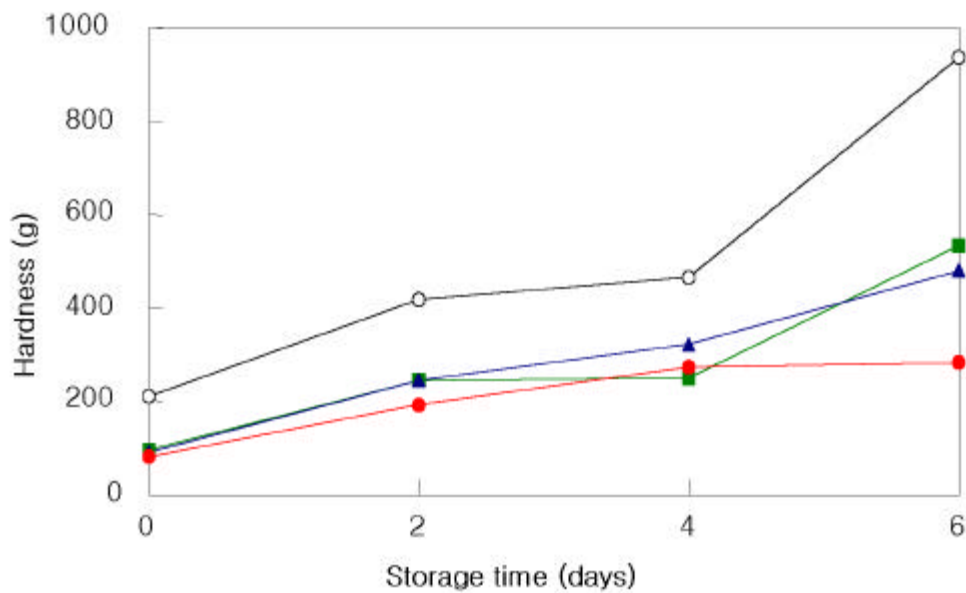
. 가

( , 1999).



**Fig. 26.** Effect of amount of *kimchi* powder on the pH of *kimchi*-added bread during storage at 25 .

(○ : Control,                      ■ : 1 % *kimchi* powder,  
 ▲ : 2 % *kimchi* powder,      ● : 3 % *kimchi* powder)



**Fig. 27. Effect of amount of *kimchi* powder on the hardness of *kimchi*-added breads during storage at 25 .**

(○ : Control,                      ■ : 1 % kimchi powder,  
 ▲ : 2 % kimchi powder,    ● : 3 % *kimchi* powder)



#### 4.5.5.

1% 3% 가

L, a b Table 14 .

2 (L) 74.63 .

1%, 2% 3% 가 (L) 75.0, 71.8 70.7

. 가 가 가

. (L) 2 , 4 6

가 가

4 가 6

가 가 . a 가 - 1.4,

- 1.3 - 1.6 . -

, 가 .

가 가 a 가 . b

가 b 가

가 가 b 가 . 3% 가

6 b 가 . b 가

가 , 가 가

가 .

**Table 14. Color value for crumb of bread containing several percent of *kimchi* powder**

| Amount of<br>kimchi<br>powder | Storage time<br>(days) | Color value |       |      | $\Delta E$ |
|-------------------------------|------------------------|-------------|-------|------|------------|
|                               |                        | L           | a     | b    |            |
| Control                       | 2                      | 74.6        | - 1.4 | 9.1  | 8.6        |
|                               | 4                      | 66.5        | - 1.3 | 9.0  | 0.7        |
|                               | 6                      | 75.2        | - 1.6 | 9.3  | 9.2        |
| 1%                            | 2                      | 75.0        | - 0.4 | 12.9 | 6.9        |
|                               | 4                      | 65.3        | - 0.3 | 11.7 | 2.8        |
|                               | 6                      | 74.5        | - 0.3 | 13.8 | 6.6        |
| 2%                            | 2                      | 71.8        | 0.4   | 17.1 | 3.6        |
|                               | 4                      | 66.5        | 0.5   | 16.5 | 1.8        |
|                               | 6                      | 72.1        | 0.5   | 18.5 | 4.3        |
| 3%                            | 2                      | 70.7        | 1.3   | 20.4 | 3.2        |
|                               | 4                      | 65.9        | 1.0   | 19.2 | 2.0        |
|                               | 6                      | 67.4        | 1.8   | 21.2 | 1.1        |

\*a-red, b-yellow, L-lightness.

\* $\Delta E$  is the alue of the size of the color difference.

•

가 , , ,  
가 가  
.

1. pH 4.0 4.7 , 0.  
5 0.8 . 24 .  
, , 7 , 5 , 5  
, 3 , 2 , 1 1  
.

2. 가 .

23 .  
aldehydes가 5 가 , alcohols 4 , acids가 4 ,  
3 , ketone 1 6 . Aldehyde  
, acid 가 ,  
.

eugenol 39.40% 가 , dodecanoic acid 4.91%, acetic  
acid 1.70%, methyl 2-propenyl disulfide 1.52%, hexanal 1.51%,  
2-pentylfuran 1.18% .  
가 .

3. 가 0%, 10%, 20%, 30% 가 10% 가 , 30% 가 , 20% 가 , , 가 .

4. 가 , 가 0%, 10%, 20%, 30% 가 20% 가 가 , , 가 가 . 20% 가 2% 가 .

5. 가 가 가 2%  $P < 0.05$  4%  $P < 0.001$  , 4% > 8% > 6% > 10% > 2% 가 . 가 4%, 8%, 6% 가 6% , 8% , 4% , , 가 가 .

6. 가 , , pH, , , 2% 2 3% 가가 . 가 가 6.6% . 가 1%, 2%, 3% 가

가 , 4 6  
900 g 가 500 g  
.

•

Acree, T.E. and R. Teranishi. 1993. Flavor science sensible principles and techniques. In : Bioassays for flavor. Acree, T.E.(ed)., ACS Professional Reference Book. American Chemical Society, Washington DC, 8 18.

Armero E., M. Baselga, A.M. Concepcion and Toldra. 1999. Effects of sire type and sex on pork muscle exopeptidase activity, natural dipeptides and free amino acids. J. Sci. Food Agric., 79, 1280 1284.

Becker, M.R. 1986. Joy of Cooking, The Bobbs-Merril Company. INC., 33 8 341.

Buck S.H. and T.F. Bucks. 1978. The neuropharmacology of capsaicin; Review of some recent observations. Pharmacology Reviews., 38, 773pp.

Cha, Y.J., H. Kim, and K.R. Cadwallader. 1988. Aroma-active compounds in kimchi during fermentation. J. Agric. Food Chem., 46, 1944 1953.

- Chang, C.H. 1967. Organic acid in Korean soy sauces. J. Korean Soc. food Sci. Nutr., 8, 1-9.
- Cheigh, H.S. and K.Y. Park. 1988. Biochemical, microbiological and nutritional aspects of *kimchi*(Korean fermentated vegetable products). *Crit. Rev. Food Sci. Nutr.*, 34(2), 175pp.
- Chen, Q., H.K. Koh, and J.B. Park. 1999. Color evaluation of red pepper power. Transaction of the ASAE, 42, 749-752.
- Cho, E.J., S.M. Lee, S.H. Rhee, and K.Y. Park 1998. Studies on the standardization of Chinese *kimchi*. Korean J. Food Sci. Technol., 30, 324-332.
- Cho, J.E., M.J. Lee, Y.B. Lee and J.R. Yoon. 1999. Comparisons of volatile compounds of *Pinus densiflora* on kinds of extraction solvent and parts of pinus. J. Korean Soc. Food Nutr., 28, 973-979.
- Cho, J.S., W.P. Park and J.H. Kim. 1996. The quality characteristics of Chinese cabbage *Kimchi* around Masan area J. Korean Soc. Food Nutr., 25(3), 535-538.

- Cho, N.C., D.Y. Chun. 1988. Effects of garlic extracts on the aerobic bacteria isolated from *kimchi*. Korean J. Food Sci. Technol., 20(3), 357-362.
- Cho, S.H., J.H. Chung and C.H. Ryu. 1994. Inhibitory effects of natural antimicrobial agent on post harvest decay in fruits and vegetables under natural low temperatures (in Korean). J. Korean Soc. Food Nutr., 23, 315-321.
- Cho, Y., and H.S. Lee. 1995. A study on flavorful taste components in *kimchi* on free amino acids. Korean J. Food Sci. Technol., 11(1), 26-30.
- Choi, H.S., Y.S. Chun and E.S. Song. 1997. Antioxidative effect of different kinds of *Kimchi* on the lipid oxidation of cooked meat. J. Korean Soc. Food Nutr., 26(6), 993-997.
- Choi, J.S. and C.H. Go. 1996. Further study on the constituents of *allium tuberosum* leaves. Arch. Pharm. Res., 19(1), 60-61.
- Choi, S.Y., M.K. Lee, K.S. Choi, Y.J. Koo, and W.S. Park. 1998. Changes of fermentation characteristics and sensory evaluation of *kimchi* on different storage temperatures. Korean J. Food Sci. Technol., 30, 644-649.

- Chun, J.K. 1981. *Kimchi* fermentability of the spring Chinese cabbage, 24(3), 194 199.
- Cousminer, J.J. 1996. Savor fruit-based salsas. Food, Technol., 50(1), 70pp.
- Curl, A.L. 1962. The carotenoids of red bell peppers. Agric. Food Chem., 10, 504.
- Donovan, M.D. 1991. The new professional chief, van nostrand Reingold, 297 302.
- Fereidoon Shahidi. 1989. Flavor of cooked meats. American Chemical Society. 188 201.
- Frankel, E.N., J. Kanner, J.B. German, E. Parks and J.E. Kinsella. 1993. Inhibition of oxidation human low-density lipoprotein by phenolic substances in red wine. Lancet. 314, 454pp.
- Fujiwara, M. 1972. Antihypercholesterolemic effect of sulfur containing amino acid, S-methyl-L-cysteine sulfoxide isolated from cabbage. Experimenta, 28, 254pp.

- Giri, J., T.K. Devi and S. Meerernani. 1984. Effect of ginger on serum cholesterol levels, Ind. J. Nutr. Diet., 21, 433 436.
- Goidman I. L., M. Kopelberg and J.E. Debaene and B.S. Schwartz. 1996. Antiplatelet activity in onion(*Allium cepa*) is sulfur dependent. Thromb. Haemost., 76(3), 450 452.
- Grosch, W. 1993. Detection of potent odorants in food extract dilution analysis. Trends in Food Sci. & Technol., 4, 68 73.
- Halliwell, B. and S. Chirico. 1993. Lipid peroxidation-its mechanism, measurement and significance. Am. J. Clin. Nurt., 57, 715pp.
- Han, J.S. 1995. Studies on whole Chinese cabbage *kimchi* - an investigation on the method of making *kimchi* and a taste in the Taegu area - J. Korean Soc. Food Sci., 11(1), 13 20.
- Hawer, W.D., J.H. Ha, and H.M. Seok. 1988. Changes in the taste and flavour compounds of *kimchi* during fermentation. Korean J. Food Sci. Technol., 20, 511 517.
- Hwang, J.M. and K.M. Chung. 1998. Evaluation of dried fruit quality and some characteristics of local red pepper(*Capsicum annuum* L.) Cultivars. J. Kor. Soc. Hort. Sci., 39, 666 669.

- Hwang, J.M. and K.M. Chung. 1998. Investigation of distribution and quality of dried red pepper(*Capsicum annuum* L.) in Andong market. J. Korea. Soc. Hort. Sci., 39, 702-706.
- Jain, R.C. 1977. Effect of garlic on serum lipids, coagulability and fibrinolytic activity of blood. Am. J. Clin Nutr., 30, 1380-1381.
- Kang, D.H., S.S. Chun, D.H. Chung and S.H. Cho. 1994. Anti-microbial effect of grape seed extract on *Vibrio parahaemolyticus* isolated from the southern adjacent sea of Korea (in Korean). Food. Hyg. Safety, 9, 141-149.
- Kang, D.H., S.Y. Jung, Y.S. Woo and Y.K. Lee. 1983. Organic constituents in *kimchi*(*Ixeris sonchifolia* H) -on free amino acids- J. Korean Soc. Food Nutr., 12(3), 2225-2229.
- Kawada, T., K. Hagigara and K. Iwai. 1986. Effect of capsaicin on lipid metabolism in rats fed diet. J. Nutr., 116, 1272pp.
- Kelly G.G. and B.M. Watts. 1957. Effect of copper chelating agents on the pro-oxidant activity of ascorbic acid with unsaturated fats. Food Res., 22, 308pp.

- Kim, S.D. S.H. Lee, W.J. Choi and O.K. Cho. 1998. The effect of mixed medicinal herb extracts with antimicrobial activity on the self-life of *kimchi*. Korean J. Food Sci. Technol., 30(6), 1404 1408.
- Kim, J.W, W.P. Park. 1990. Study on the measurement of *kimchi* maturity by weight measuring method. J. Korean Agric. Chem, Soc., 33(3), 257 260.
- Kim, K.J., H.K. Kim, K.H. Kyung, W.K. Myung and S.T. Shim. 1989. Selection scheme of radish varieties to improve storage tabilities of fermented pickled radish cubes with special reference to sugar content. Korean J. Food Sci. Technol., 21(1), 100 108.
- Kim, M.K., S.Y. Kim, C.J. Woo and S.D. Kim. 1994. Effect of air controlled fermentation on *kimchi* quality (in Korean). J. Korean Soc. Food Nutr., 23, 268 273.
- Kim. M.H., S.W. Oh, S.P. Hong and S.K. Yoon. 1998. Antimicrobial characteristics of chitosan and chitosan oligosaccharides. Korean J. Food Sci. Technol., 30, 1439 1447.
- Kim, J.K and C.S. Kim. 1980. The taste components of ordinary Korean sauce. J. Korean Agric. Chem., 23, 89 105.

- Kim, S.D. 1985. Effect of pH adjuster on the fermentation of *kimchi* (in Korean). J. Korean Soc. Food Nutr., 14, 259-264.
- Kim, S.D., H.G. Noh and I.K. Park. 1995. Extension of shelf-life of *kimchi* by addition of chitosan during salting. J. Korean Soc. Food Nutr., 24(6), 932-936.
- Kim, S.D., M.J. Kim and K.S. Jang. 1995. Effect of ginseng on the preservability and quality of Chinese cabbage *kimchi*. J. Korean Soc. Food Nutr., 24(2), 313-322.
- Kim, S.D., W.D. Hawer and M.S. Jang. 1998. Effect of fermentation temperature on free sugar, organic acids and volatiles of *kakdugi*. J. Korean Soc. Sci. Nutr., 27, 16-23.
- Kim, S.H., Y.H. Kim, Z.W. Lee, B.D. Kim and K.S. Ha. 1997. Analysis of chemical constituents in fruit of red pepper. 38, 384-390.
- Kim, Y.J., W.S. Park, K.H. Ku, M.R. Kim and J.J. Jun. 2000. Inhibitory effect of baechu *kimchi* (Chinese cabbage *kimchi*) and *kakdugi* (radish *kimchi*) on the diethylnitrosamine and D-galactosamine induced hepatocarcinogenesis. Food Sci. Biotechnol., 9, 89-94.

- Ku, K.H., J.S. Cho, W.S. Park and Y.J. Nam. 1999. Effects of sorbitol and sugar sources on the fermentation and sensory properties of baechu *kimchi*. Korean J. Food Sci. Technol., 31, 794-801.
- Kwon, H.S. 1999. Change in physicochemical properties and microorganisms during the storage of *kimchi*-stew's sauce. J. Korean Soc. Food Sci. Nutr., 28, 107-112.
- Lea C.G. and P.A.T. Swoboda. 1956. Antioxidative activity of flavonoids gossypetin and quercetagenin. Chem. Ind., 1426pp.
- Lee, I.S., W.S. Park, Y.J. Koo and K.H. Kang. 1994. Changes in some characteristics of brined Chinese cabbage of fall cultivars during storage (in Korean). Korean J. Food Sci. Technol., 26, 239-245.
- Lee, M.J., Y.B. Lee, H.S. Kwon and J.R. Yoon. 1998. Isolation and identification of volatile compounds extracted from twigs of *Pinus densflora* with Likens-Nickerson apparatus. J. Korean Soc. Food Nutr., 27, 568-573.
- Lee, H.S., J.Y. Yu and H.S. Lee. 1984. Changes of organic acids and volatile flavor compounds in *kimchis* fermented with different ingredients. J. Food Sci. Technol., 16(2), 169-172.

- Lee, M.J., E.J. Jung, S.J. Lee, J.E. Cho and Y.B. Lee. 2002. Comparisons of volatile compounds extracted from *Pinus densiflora* by headspace analysis. J. Korean Soc. food Sci. Nutr., 31(1), 26 31.
- Lee, S.H. and W.J. Choi. 1998. Effect of medicinal herbs extracts on the growth of lactic acid bacteria isolated from *kimchi* and fermentation of *kimchi* (in Korean). Korean J. Food Sci. Technol., 30, 624 629.
- Lee, S.H., O.K. Cho and N.Y. Park. 1998. The mixed effect of *Salvia miltiorrhiza* and *Glycyrrhiza uralensis* on the shelf-life of *kimchi*. J. Korean Soc. Food Sci. Nutr., 27, 858 853.
- Lee, S.H. and O.K. Cho. 1998. The mixed effect of litho-spermum erythrorhizon, glycyrrhiza uralensis extracts and chitosan on shelf-life of *kimchi* (in Korean). J. Korean Soc. Food Nutr., 27, 864 868.
- Lee, S.H., Y.S. Lim and W.J. Choi. 1997. Effect of *schizandra chinensis* (Omija) extract on the fermentation of *kimchi*. Kor. J. Appl. Microbiol. Biotechnol., 25(2), 229 234.
- Lee, S.H. J.O. Ha and K.Y. Park. 1996. A study on the contents of dietary fibers and crude fiber in *kimchi* ingredients and *kimchi*. J. Korean Soc. Food Nutr., 25(1), 69 75.

- Lin R.I. 1994. Phytochemicals and antioxidants. In "functional food : designer foods, pharmafoods, nutraceuticals" goldberger, i(ed). Champman & Hill. New york. 396pp.
- Manning, T. 1983. Quality control in food service, Chapman & Hall London. New York, 157 159.
- Miller, G.L. 1959. Use of dinitrosalicylic acid reagent for determination of reducing sugar. Anal. Chem., 31, 426 428.
- Moon, K.D., J.A. Byun, S.J. Kim and D.S. Han. 1998. Screening of natural preservatives to inhibit *kimchi* fermentation. Korean J. Food Sci. Technol., 27, 858 863.
- No, H.K., I.K. Park and S.D. Kim. 1995. Extension of shelf-life of *kimchi* by addition of chitosan during salting. J. Korean Soc. Food Nutr., 24, 932 936.
- Oh, Y.A. and K.H. Kim. 1998. Effect of addition of water extract of pine needle on tissue of *kimchi* (in Korean). J. Korean Soc. Food Nutr., 27, 461 470.

- Park, J.B., W.S. Park, D.M. Kim, J.h. Kim, K.H. Kwan, S.M. Lee, G.H. Kim, Y.S. Shin and H.K. Ko. 1999. Development automation system for red pepper milling factory. In Research Report of Agriculture Department KFRI, GA0129 9916.
- Park, K.Y. 1995. The nutritional evaluation and antimutagenic and anticancer effects of *kimchi*. J. Korean Soc. Food Nutr., 24(1), 169 173.
- Park, K.Y., S.H. Lee, J.S. Han and K.Y. Lee. 1995. Kinds and characteristics of traditional special *kimchi*. J. Korean Soc. Food Nutr., 24(5), 734 743.
- Park, W.P. and J.W. Kim. 1991. The effect of spices on the *kimchi* fermentation. J. Korean Agric. Chem. Soc., 34, 235 241.
- Park, W.P., K.D. Park and S.H. Cho. 1996. Effect of grapefruit seed extract on *kimchi* fermentation. Foods and Biotech., 5, 91 93.
- Song, S.H., J.S. Cho and K. Kim. 1996. Studies no the preservation of the "kimchi". Part 1. Effects of preservatives on "kimchi" fermentation (in Korean). Report of the army research and testing laboratory, 5, 5 9.



, , . 1998.

. . 22(1), 62-67.

, . 1990. , , 137pp.

, . 1993. . , 1-359.

, . 1996.

kinetics . . 10(1), 65-67.

, , . 2000. 가 ,  
. 47 , 33pp

, , , , . 2001. 가  
, , 17(3), 1-9.

. 1985. . , 114pp.

. 1997. .  
, , 15pp.

, , . 1995. 가가  
. , 24(2), 313-322.

- , . 1998. .  
, 30(3), 542 548.
- , , , . 1998. .  
, 30(2), 391 396.
- , , . 1997. Model Melanoidin  
. , 29(5), 1045 1052.
- , . 1984. 가  
. , 12(2), 153pp
- , . 1992.  $\beta$  - carotene  $\alpha$  - tocopherol  
lipoxygenase . , 24, 37 41.
- , , . 1995. 가  
, 24(4), 542 650.
- , , , , . 1997.  
. , 26(5), 814 821.
- . 1995. 가  
, 24(1), 169 182.

, , , . 1998. .  
 , 30(2), 324 333.

, , . 1997. 가가 C  
 . . 42 , 72 73.

, , . 2002. .  
 , 78pp.

. 1990. 가 .  
 .

, . 1991. , .  
 , 34(3), 242 248.

, , , , . 2000.  
 . , 29(1), 30 34.

, . 1994. 가가 .  
 , 23(4), 618 724.

, , , , , . 1997.  
 ( ). , 358 395.

, , . 1997. 5  
xanthin oxidase . , 26(3), 411 416.

, , . 1999. 가가  
, , 28(1), 113 118.

. 2000. . , 1(1), 79 88.

, . 1983. . , 12(3), 225pp.

, , . 1996. Flavin-3-ol xanthin  
oxidase . , 28(6), 1084 1088.

, , , . 1974. citric acid  
. , 6(4), 193 198.

, . 1997. 가  
. , 30(10), 1188 1194.

, . 1994. 가. .  
, 226 245.

. 1995. 가 .  
, 1, 143 144.

, , , , , . 1997. capsaicin *in vivo*

. . , 101pp.

. 1994. . , 34 42.

, , , . 1995. .

. , 24(5), 734 743.

, , . 1997. 가

. , 118pp.

, , . 1999. 가

, , 273pp.

. 1986. . , , 141pp.

. 1989. . . 8(2), 20pp.

. 1996. .

. .

, . 1996. ., , 6(1), 66 71.

, 1995.

. , 24(6), 1005 1009.

. 2000. methanol

.

, . 1985. Gingerol . , 17(2), 55 59.

, , , , , , , , ,

. 2002. .

, 34(1), 85 90.

, , . 1998. Melatonin 가  
(senescence-accelerated mouse, SAM)  
, 146pp.

, 1994. Free radical scavenger plant phenolic  
. , 4(1).

, , . 1992. Ames test  
Retinoic acid,  $\beta$ -carotene Ascorbic acid  
. , 24, 4pp.

, , , , . 1994.

capsaicin oleoresin .

, 26, 496 499.

. 1998. . ,

.

, , , . 1993.

. . 93 , 195pp.

, , , . 1996. 가

. . , 22pp.

, , . 1995. 가가 .

, 24(2), 330pp.

, . 2000. ( Fusion Food ) / 가

. , 16(3), 299pp.

, , , , . 1995.

. , 24(1), 54pp.

- , . 1986. . Part ;  
Effect of garlic components on electron donation ability and  
inhibitory effect of lipoperoxide formation. 가 , 24(1), 4  
3 51.
- . 1994. . , 5 20.
- . 2001. . , 27pp.
- . 2002. . .
- . 1990. The Professional Chief. , 98 108.
- . 1992. , , 141 149.
- , . 1979. .  
, 11(1), 26pp.
- . 1988. . . 3(2), 107
- , , , . 1999. *in vitro* ,  
, 28(6), 1326 1332.

. 1994. , . , 13 70.

, , , , , . 1990. .  
, 151 283.

, , . 1992.  
. , 35(4), 248 253.

. 1994. , , 18 19.

. 1999. . , 31 60

. 1991. . , 6(4), 527 536.

. 1992. 香料.藥味.香辛料 植物百科, , 37 57.

. 1999. . .

, , . 1996. . , 23pp.

. 1989. .

.

， ， ， ， ． 1988． 20(4), 511pp.

中村勝煥． 2000． フォンとソース． 梨田書店, 44pp.

田中嘉子． 1999． 天然調味料の利用とれからの傾向と発展について． 食品加工, 495pp.