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Sensory Evaluation of *Kimchi* using Two Ethnic Groups

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Abstract

Kimchi was investigated with regard to the sensory properties depending on ethnic group and processing conditions, and to the relationship between its sensory attributes. Sensory panel scores of American in sourness, pungency and crunchiness were significantly higher than those of Korean. The opposite result was performed in sweetness. There were no significant differences between American and Korean in sensory properties of saltiness, hardness and toughness. Salt content in brine was significantly related to saltiness of *kimchi* at $p<0.001$. Sensory panel scores of saltiness in *kimchi* made with 10, 15 and 20% salt solution appeared to be 4.5, 5.8 and 7.1, respectively. Mean values of toughness were 5.7 at 3 days of aging and 4.5 at 10 days. There were no relationship among sensory properties between taste attributes and textural terms of *kimchi*.

Key workds: *kimchi*, sensory property, ethnic group

Introduction

Kimchi is the general name given to a group of fermented vegetable foods with a long tradition in Korea. More specific names are used for these pickled vegetables depending on the raw materials, processing methods, seasons and locations. Although the proper combination of minor ingredients has been used to be a key for delicious and palatable *kimchi*, the more important factors seemed to be the salt concentration and fermentation.[1]

Kimchi is characteristic in its palatability giving sour, sweet and carbonated taste and greatly differs in this respect to sauerkraut which is popular in the west. The texture of *kimchi* was changed depending on the leangth of fermentation, temperature, condition of the chinese cabbage, and salt concentration.[2] Head cabbage was softened more easily than non-headed cabbage, while over-salting had brought about a toughening of the tissue and delayed in softening.

Ryu *et al.*[3] studied the effects of organic acids, acidity and carbon dioxide toward sensory properties of *kimchi*, and suggested that there were no relationships between chemical contents and sensory characteristics. On the contrary, sourness of *kimchi* was decreased as lactic acid contents increased in water and buffer solutions.[4] The palatabilities of 1.02% salt-containing *kimchi* was superior to that of 3.16% salt-containing *kimchi*.[5] In addition, low salt content of *kimchi* had higher palatability compared to high salt content of *kimchi*.[6]

As mentioned in above most researches on the sensory properties of *kimchi* have been concentrated to define the effects of process conditions and chemical components in *kimchi*.

The purposes of present work were to evaluate the difference of sensory responses on *kimchi* between American and Korean, to study the effects of salt concentration in brine and of aging time on sensory attributes of *kimchi*, and to determine the relationships between sensory terms of *kimchi*.

Materials and Methods

All the raw materials required for preparation of *kimchi* were purchased from local oriental grocery store (Columbia, MO). The raw materials were stored in 5℃ until used.

Korean cabbages, cut into small pieces (4-5 cm), were salted with 10, 15 and 20% salt solution for 3 hrs and washed twice with 2.0% brine. After draining brine, spices and other minor ingredients were added and mixed. Spices and other ingredients were blended to paste prior to addition. The mixed paste were composed of 2 g red pepper powder, 2 g fresh green onion, 2 g fresh garlic, 0.5 g fresh ginger, 0.8 g sucrose, 0.035 g monosodium glutamate, 0.22 g sesame,

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and 9 g liquid-anchovy sauce per 100 g cabbage. Each samples of *kimchi* prepared were packaged in glass bottle, which has contained 400-450 g of *kimchi*. Aging *kimchi* was carried out at 5℃ for a period of 3 and 10 days.

Sensory properties of *kimchi* were evaluated on terms of sourness, saltiness, pungency and sweetness for taste attributes, and hardness, crunchiness and toughness for textural evaluation by the Quantitative Descriptive Analysis. Five Americans and 5 Koreans participated in the sensory test. Koreans were all graduate students majoring in Food Science and Americans also graduate students who have tasted *kimchi* one more time before or were sincerely interested with the foreign foods. Prior to serving, *kimchi* were adjusted to room temperature. A set which included 3 samples of *kimchi* (10, 15 and 20% of salt solution) were presented to each judge by random order. Sensory evaluation of *kimchi* was performed in duplicate for repliation. All tests have been done in the fixed boot and on the conditon of incandescent light. All sensory properties of *kimchi* were evaluated using a graphic scale, of which distance was 10 cm (0= weak, 10=strong).

Sensory data were analyzed statistically using the SAS program.[7] The programs used were PROC ANOVA and PROC FACTOR. Five-way analysis of variance was accomplished depending on the each sensory property.

Results of Discussion

Ethnic group appeared to be a very important factor for the differnce of response intensities on sourness, pungency, sweetness and crunchiness of *kimchi* (Table 1). However, there were no significatn differences between American and Korean in sensory properties of saltiness, hardness and toughness of *kimchi*. Salt content in brine was significantly related to the saltness of *kimchi* at $p<0.001$. Sensory panel scores of saltiness in *kimchi* made of 10, 15 and 20% salt solution were 4.5, 5.8 and 7.1 under overall consideration of ethanic group and aging time, respectively. Toughness of *kimchi* ws highly related to aging time ($p<0.01$). Sensory panel scores of toughness were 5.7 at 3 days of aging and 4.5 at 10 days. The softening phenomena of *kimchi* during aging may be derived by yeast activity appearing at the later stage. The interaction effect of aging time and ethnic group was presented on crunchiness of *kimchi*. American has not found the difference of crunchiness among 3 (mean value=6.2) and 10 days (mean value=6.6). Otherwise, Korean revealed that crunchiness of *kimchi* ripened for 10 days (mean score=5.0) was significantly reduced compared to mean value (6.0) after 3 dyas. Crunchiness of Korean seems to be almost similar to the result of toughness perceived.

Fig. 1 represents a spider-web diagram of sensory differences in *kimchi* between two ethnic groups by polar coordinates. The specific values on each sensory attributes indicate the mean perceived intensities which are derived from all the intensities evaluated by one ethnic regardless of 3 and 10 days aging. The response intensities of American in sourness, pungency and crunchiness were higher than those of Korean. American was very sensitive to pungency

Table 1. Analysis of variance on the sensory properties of *kimchi*

Source of variance	df	Taste property				Textural property		
		Sour	Salty	Pungent	Sweet	Hard	Crunchy	Tough
J	4	*	*	*	*	ns	**	ns
S	2	ns	***	ns	ns	ns	ns	ns
A	2	ns	ns	ns	ns	ns	ns	**
E	1	***	ns	**	*	ns	**	ns
R	1	ns	ns	ns	ns	ns	*	ns
S×A	2	ns	ns	ns	ns	ns	ns	ns
S×E	2	ns	ns	ns	ns	ns	ns	ns
A×E	1	ns	ns	ns	ns	ns	*	ns
S×A×E	2	ns	ns	ns	ns	ns	ns	ns
N	120							

J: judge, S; salt concentration in brine, A; aging time, E; ethnic group, R; replication, N; number of total observation in each property
ns: non-significant statistically
*significant at $p<0.05$, **significant at $p<0.01$, ***significant at $p<0.001$

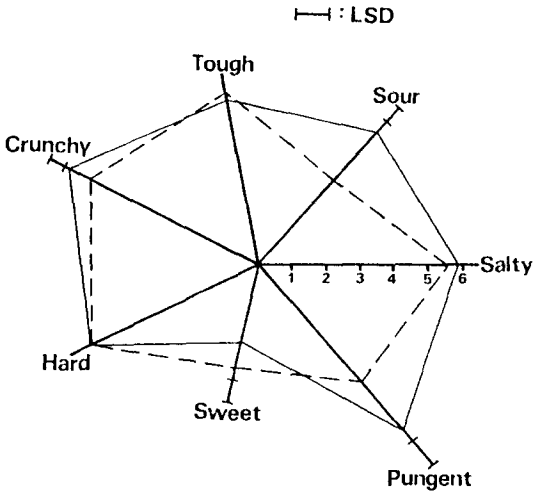

Fig. 1. A spider-web diagram of difference between two ethnic groups in sensry properties of *kimchi*
The solid line is for American, the broken line for Korean. The distance from the center of the diagram reflects the magnitude of the mean for each sensory attribute. LSD means least significant difference

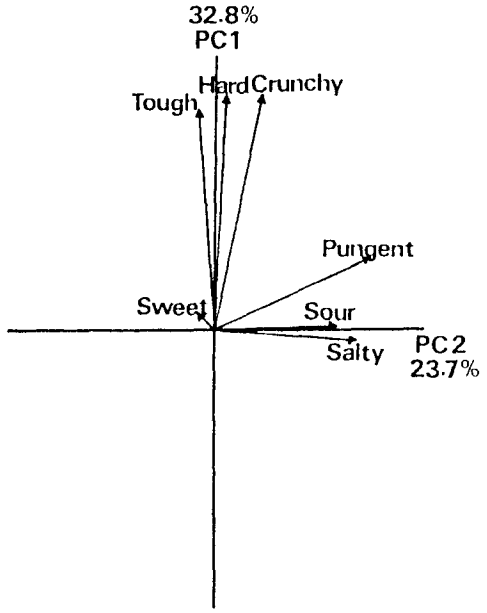

Fig. 2. Interrelationships between sensory attributes perceived from *kimchi*

and sourness while Korean less sensitive than American due to the use of *kimchi* as a sidedish everyday. On the other hand, the responses of Americans in sweetness of *kimchi* appear to be lower than those of Koreans. This result may be largely caused by their own food habit and amount of sugar consumption per year per person. The less response intensity of sweetness by American is also derived by masking with their high pungent and sour scores to *kimchi*.

Data from the plot of the rotated factor patterns (Varimax) of sensory properties in *kimchi* indicated that the first two principal components accounted for 56.5% of total variation of sensory properties (Fig. 2). On the plot of the first two principal components, sourness, saltiness and pungency of *kimchi* were placed simultaneously in positive direction of principal component 2 (PC 2) that accounted for 23.7% of the total variance of sensory properties. Therefore, PC 2 could be named as 'taste factor' in *kimchi*. Contrary to PC 2, principal component 1 (PC 1), which was called as 'texture factor', accounted for the relationships among hardness, crunchiness and toughness of *kimchi* . Three textural terms of *kimchi* were in the positive direction of PC 1 which accounted for 32.8% of total variation. Therefore, it can be concluded that there are no relationships among sensory properties between taste attributes and textural terms of *kimchi*.

In conclusion, the perceived intensities on sensory properties of *kimchi* would be different according to the ethnic group. *Kimchi* is now growing into an international foods. Hence, the preparing conditions of *kimchi* for foreigners might be differentiated from usually making process to fit their needs on sensory attributes of *kimchi*. More concerns about their food habits are required to make Korean *kimchi* into world-wide used foods.

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두 인종간의 김치의 관능특성 차이

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김치의 관능특성을 김치의 제조 공정조건과 인종간의 차이 관점에서 평가하고, 관능특성간의 상관관계를 설정하였다. 신 맛, 얼얼한 맛, 바삭바삭한 특성에서는 미국인의 관능치가 한국인보다 높았으며, 단 맛에서는 반대의 결과를 나타내었고 짠 맛, 견고성, 질긴 면에서는 두 인종간에 차이가 없었다. 김치 제조시 소금물의 농도가 김치의 짠 맛에 영향을 주며, 10, 15, 20%의 소금물을 사용했을 때 짠 맛의 평균값은 4.5, 5.8, 7.1로 증가하였다. 질긴 정도의 관능치는 3일 숙성이 5.7 이었으며, 10일 숙성 후에는 4.5로 감소하였다. 김치의 관능특성 중 맛 특성과 조직감 특성간에는 어떠한 상관관계도 존재하지 않았다.