

Understanding the Factors Affecting the Acceptance for Fermented Soybean Products

Lana Chung and Seo-Jin Chung^{1*}

Department of Food and Nutrition, Inha University, Incheon 402-751, Korea

¹Department of Food and Nutrition, Seoul Women's University, Seoul 139-774, Korea

Abstract The main objective of this study was to understand the factors affecting the acceptance of fermented soybean products. Seventy-six consumers rated the acceptance and perceived intensity of 4 types of Korean and 4 types of Japanese style fermented soybean products. The consumer's food variety seeking tendency and the general attitude toward various fermented soybean products were measured. Ten descriptive analysis panelists evaluated the sensory characteristics of the 8 samples. Univariate and multivariate statistical analyses were applied to the data sets. Fermented soybean products consisting of sweet and moist sensory characteristics were preferred the most. The variety seeking tendency was not an effective predictor for understanding the acceptance of the products tasted in the experiment. *K*-means cluster analysis identified 3 sub-consumer segments sharing a common preference pattern for the 8 samples within each group. These 3 groups somewhat differed in the consumption frequency, acceptance, and familiarity of various fermented soybean products in general.

Keywords: fermented soybean, acceptance, *miso*, *doenjang*, food attitude

Introduction

Many researchers have attempted to understand the food acceptance from various perspectives. Understanding the consumer acceptance from a cultural context may be a very effective approach. Even when there are clear evidences that individual's taste sensitivity are directly related to one's acceptance for a food (1,2), the sensitivity for a specific taste/flavor attributes can be acquired from mere exposure which is often dominated by the cultural context (3). Additionally, familiarity, exposure, expectations, beliefs concerning foods, which are non-sensory factors but are all subjected to cultural framework, are shown to influence the liking for food (4,5). In general, consumers tend to prefer food products or sensory characteristics that are familiar. When consumers encounter an unfamiliar product, consumers tend to perceive the product aligning with the products they already know (6) and thus build up their expectations and acceptance based on this perception (7).

Individual's food attitude is another factor affecting the acceptance and consumption of food (8). Studies show that one's perception for a food can considerably depend on whether a person is health oriented (9), variety seeker (10), and restrained eater (11). Thus, many scales such as the VARSEEK scale (12), the Food Neophobia scale (13), and the Health and Taste Attitude scales (14) have been developed and effectively utilized to investigate the relationship between the consumer attitudes and food acceptance. The VARSEEK scale developed by Van Trip and Steenkamp (15) measures the tendency to seek variety in food choices and is reported to be negatively correlated with the Food Neophobia scale (16). The VARSEEK scale has been shown to successfully delineate the consumption pattern of

cheese (15) and is useful for understanding the reported food choice and consumption behavior among consumers.

Fermented soybean products are heavily consumed in Korea, Japan, China, etc. Traditionally manufactured fermented soybean paste in Korea seems to be excellent in its content and composition of free amino acids due to the involvement of natural strains as compared with commercially manufactured fermented soybean paste that inoculated with *koji*, etc. (17). Moreover, functionalities of physiological active substances such as anti-oxidativity (18,19), anti-mutagenicity (20), ACE inhibitor (21), thrombolysis (22), etc. are recently confirmed from traditionally fermented soybean paste. Thus, new recognition for soybean paste is spreading among the young consumers who avoid traditional soybean paste as well as the older generation. Nevertheless, commercially manufactured soybean paste is more consumed than traditional soybean paste due to the change in lifestyles (17). Today, even with the excellent physiological functionality, the fermented soybean consumption is decreasing due to the unpleasant aroma stemming from fermentation processes and cooking. The studies show that the acceptances for fermented soybean stew among the children and adolescents is especially low (23-26).

The fermented soybean products from different countries have distinctive quality but also share some common characteristics concerning the ingredients and fermentation methods. Roughly speaking, Korean *meju*, *doenjang*, and *saeng-cheonggukjang* correspond to Japanese *koji*, *miso*, and *natto*, respectively. Identifying the critical factors affecting the consumer acceptance for fermented soybean products should be the first critical step to increase the consumption of fermented soybean products. Thus in this study, various types of Korean and Japanese fermented soybean products, which varies in the sensory characteristics and have different cultural context to Korean consumers, were chosen to investigate how sensory and non-sensory factors affect the consumer's acceptance for fermented

*Corresponding author: Tel: +82-2-970-5649; Fax: +82-2-976-4049

E-mail: sjchung@swu.ac.kr

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soybean products. The objectives of this study were 1) to measure the liking for various fermented soybean pastes which varies in the degree of familiarity to Korean consumers; 2) identify the sensory characteristics that drives the consumer's acceptance of the fermented soybean products; 3) to investigate whether consumer's variety seeking tendency directly accounts for the acceptance of fermented soybean pastes.

Materials and Methods

Materials Four fermented soybean products from Korean manufacturers and another 4 fermented soybean products from Japanese manufactures were evaluated. The 4 Korean samples were *doenjang* made by traditional method [TDJ] (Suzinwon, Yangpyong, Ganwon, Korea), *doenjang* made by commercially manufactured method [MDJ] (Haechandle Co., Gongju, Chungnam, Korea), *cheonggukjang* [MCG] (Paranae Foods Co., Ltd., Chungsong, Chungbuk, Korea), and *saeng-cheonggukjang* [SCG] (Sunchanggol Co., Sunchang, Jeonbuk, Korea). The 4 Japanese samples were rice/barley-*koji miso* [AMS] (Marusan-Ai Co., Ltd., Aichi, Japan), rice-*koji miso* [WMS] (Ishinomiso Co., Ltd., Gyoto, Japan), soybean-*koji miso* [NMS] (Nakamo Co., Aichi, Japan), and *natto* [NTT] (Takanofoods Co., Ltd., Ibaraki, Japan).

In order to facilitate the understanding of the samples, a brief description of each sample category is presented in the following. Traditionally manufactured *doenjang* are made from *meju* (27). The primary microorganisms involved in *meju* fermentation are *Bacillus subtilis* but other microorganisms can also be involved since the *meju* is fermented in natural environment. Commercially manufactured *doenjang* is frequently made from soybean mixed with barley or rice which is then inoculated with *Aspergillus oryzae* (27,28). *Seang-cheonggukjang* is made with whole cooked soybean fermented for 2-3 days with *B. subtilis* without adding salt (29). After the fermentation, very thin string like sticky substance is formed in soybean. *Cheonggukjang* is similarly processed as *seangcheonggukjang* but is further mashed and salt is added (30).

Regarding the Japanese samples, *miso* is made from '*koji*' which is prepared from steamed rice, barley, or soybean inoculated with *A. oryzae*. White *miso* is fermented with rice *koji* whereas *miso* made with soybean-*koji* is called *aka-miso* or red *miso*. *Awase-miso* is obtained when a mixture of rice and barley is used as *koji* (31-34). *Natto* is a fermented cooked soybean inoculated by *Bacillus natto*, which is identified as *B. subtilis*. The *B. natto* produces a fairly strong and a sticky, slippery surface texture (35,36).

The Korean samples used in this study were purchased in local stores near Inha University (Incheon, Korea) and the Japanese samples were purchased in department stores near Shinjuku subway station (Tokyo, Japan). The fermented soybeans were kept in room temperature (22±2°C). One hr prior to the experiment, 30 g of each soybean sample was weighted into the serving container which then was immediately closed.

Subjects Seventy-six subjects consisting of 17 male and 59 females (age: 18-30) who showed interests in participating

on consumer taste testing of fermented soybean products were recruited at Inha University.

Consumer taste test The panelists (n=76) evaluated a total of 8 fermented soybean samples. Panelists came to 2 sessions on different days with each session consisting of 4 samples. The 4 samples were presented simultaneously in random order. The samples were assigned with 3-digit random numbers and served under identical conditions. The acceptance and sensory characteristics of the fermented soybean sample were assessed by tasting the sample which was picked (approx. 2 g) by an odorless melamine stick.

The panelists evaluated the acceptance of overall (OvL), appearance (AppL), color (ColL), aroma (AroL), taste (TstL), aftertaste (AftL), and texture (TxtL) attributes of the samples using a 9-point hedonic scale ranging from 1 ('dislike extremely') to 9 ('like extremely'). They were also asked to rate the perceived intensity of salty (SltI), fermented flavor (FrmtI), rich flavor (RchI), and artificial seasoning (ArtSsnI) flavor on a 9-point category scale with an anchor phrase 'not detectable' on the left and 'extremely strong' on the right. Additionally, the degree of flavor familiarity (Famlr) of the sample was also measured on a 9-point category scale.

At the end of the experiment, panelists filled out a self-administered questionnaire concerning the consumption frequency (daily/once or more per week/once or more per month/once or more per 3-4 months/once or more per year/not consuming), preference (5-point category scale), and familiarity (5-point category scale) of *doenjang*, *cheonggukjang*, *miso*, and *natto*. Finally, the variety seeking tendency (VST) of each panelist was measured using the VARSEEK scale developed by Van Trijp and Steenkamp (15). After calculating the sum of VARSEEK score, the consumers scoring more than 30 were defined as high variety seekers and consumers scoring lower than 30 were defined as low variety seekers.

Descriptive analysis Ten trained Korean descriptive analysis panelists evaluated the sensory characteristics of the 8 samples. The descriptive analysis consisted of training sessions and main experiment. Forty-eight attributes were developed and defined during the training sessions and the intensities of the 48 sensory attributes for the 8 samples were rated in the main experiment using a 15-cm line scale labeled with words, specifically 'weak' on the left and 'strong' on the right, at the 1.25 cm inner side of both ends. In each session, all 8 samples were presented simultaneously in random order. Panelists had 15-min break after evaluating the first 4 samples to prevent sensory adaptations. Panelists were not permitted to eat or drink other than water 1 hr prior to the descriptive analysis session. Panelists rinsed their mouth 5 times with spring water between samples. Each session took approximately 1 hr and the descriptive analysis was conducted in 3 replications. The detailed information regarding the panelists training methods, definitions, and standards of the attributes and descriptive analysis procedure are described in Chung and Chung (37).

Statistical analysis General linear model [product+product * VST+VST+VST (panelist)] (GLM) was performed to evaluate the effect of the product type and variety seeking

tendency (VST) on the acceptance and perception of the fermented soybean samples. When the samples showed significantly different intensities for each attribute, Duncan's multiple range test was performed to compare the significant differences ($p < 0.05$) between the samples for the corresponding attribute. Pearson's correlation analysis was conducted to the consumer taste test data set. Partial least square regression analysis (PLSR) was conducted on the mean values of the descriptive data and the consumer data as X and Y variables, respectively, to delineate the critical sensory attributes affecting the acceptance of fermented soybean products.

In order to understand the sub-consumer segments who share a relatively common preference pattern for the fermented soybean products, *k*-means cluster analysis was performed to the overall liking data of the 8 soybean samples. Three consumer groups were identified. The mean overall liking data of these 3 groups along with the descriptive analysis data were subjected to the external preference mapping (EPM) analysis. In the EPM analysis, principal component analysis (PCA) was initially performed to the mean attribute values of the descriptive analysis data set to obtain 2 significant PCs. The overall liking scores of each group were then regressed against the PC scores. Chi-square analysis was conducted separately to test whether the VST low and high groups or *k*-mean cluster groups differ on the consumption frequency of various types of fermented soybean. Additionally, analysis of variance were conducted separately on the VST group and *k*-means cluster group to evaluate whether significant differences exist in the general liking or familiarity of various fermented soybean products between low and high VST group or among the 3 *k*-means cluster groups. GLM, ANOVA, and cluster analysis were analyzed using SPSS® version 12.0 (Chicago, IL) and PLSR, EPM, and PCA were conducted using XLSTAT® 2007 (Paris, France).

Results and Discussion

The consumer acceptance and intensity perception of 8 fermented soybean products The 8 fermented soybean products significantly differed in their ratings for all the acceptance and the perceived sensory intensity attributes, when the ANOVA was conducted to the consumer data set (Table 1, $p < 0.05$). Among the 8 products, MDJ, AMS,

WMS samples, which were commercially manufactured *doenjang*, *miso* made with rice/barley *koji*, and rice *koji miso*, respectively, were rated the highest in the overall liking. The other 5 samples were rated below the rating 'neither like nor dislike'. The aroma liking and taste liking showed similar rating patterns to that of the overall liking. The appearance of MDJ, AMS, and WMS were also the most preferred but the appearance of NMS, which was made of soybean-*koji*, was the least preferred. The texture of Japanese *miso* sample WMS, which is characterized as being smooth and moist, was preferred the most, followed by AMS (Fig. 1).

Concerning the perceived intensity of the samples, the Korean traditionally manufactured *doenjang* was rated the strongest in saltiness, fermentation, and rich flavor. The saltiness of MDJ, AMS, and WMS were rated as the second highest intensity. Discussing the results of this consumer study based on other related research is somewhat limited since the previous studies concerning the fermented soybean products mainly focused on processing method (38) and fermentation and chemical composition of soybean paste (34,39-42) within the same category of fermented soybean. The studies, which have compared the quality between the Korean *doenjang* and Japanese *miso*, have measured the sodium and potassium content and taste components of the 2 product categories (43,44) but lack in the comprehensive research concerning the comparison of the consumer acceptance of the 2 products.

The consumers perceived the flavor of MDJ and AMS as the most familiar, followed by MCG and TDJ. The degree of flavor familiarity showed significantly positive correlations with the overall liking ($R^2 = 0.454$, $p < 0.0001$) and the taste liking ($R^2 = 0.494$, $p < 0.0001$) ratings of the samples. In general, consumers tend to prefer food products or sensory characteristics that are familiar. Birch (45-47) showed that familiarity and sweetness accounted for a total of 50-60% of the variance in the children's preference data. Zajonc (48) proposed that the acceptance for stimulus increases with increasing exposure. The effects of mere exposure on liking for food were demonstrated in several studies (49,50). It was evident that the Korean consumers tend to be more familiar with the Korean samples although rice/barley *koji miso* (AMS) was rated higher than traditionally manufactured *doenjang*. This is partly supported by the observation regarding the consumption frequencies

Table 1. The mean liking and perceived intensity ratings of 8 fermented soybean product

Sample	OvL ¹⁾	AppL	CoLL	AroL	TstL	Sltl	Frmtl	Rchl	ArtSsnl	AftL	TxtL	Famlr
TDJ ²⁾	4.4ab ³⁾	3.9b	3.9b	4.4b	4.2b	7.2e	6.4d	6.6d	6.2c	4.0a	4.6a	4.9bc
MDJ	5.8c	5.4d	6.1c	6.0c	5.9d	6.1d	5.2b	5.8c	5.6c	5.3cd	5.6b	6.1e
MCG	4.9b	3.7b	4.4b	4.7b	4.9c	4.3c	5.1b	4.6b	4.5b	4.8bc	4.4a	5.3cd
SCG	4.3a	4.6c	5.4c	4.3b	4.2b	3.0a	5.2b	4.0a	3.6a	4.3ab	4.5a	4.4b
AMS	5.8c	5.7d	5.9c	5.5c	5.6d	6.4d	5.2b	5.7c	6.1c	5.3cd	6.1bc	5.7de
WMS	5.8c	5.4d	5.5c	5.6c	5.5d	3.7b	3.6a	3.7a	4.6b	5.6d	6.4c	3.7a
NMS	3.9a	2.2a	2.2a	4.1ab	4.4bc	6.3d	5.1b	6.1c	5.7c	4.0a	4.7a	4.4b
NTT	4.0a	4.8c	5.5c	3.6a	3.5a	3.2ab	5.8c	4.5b	3.6a	3.8a	4.5a	3.8a

¹⁾OvL-Overall liking; AppL-appearance liking; CoLL-color liking; AroL-aroma liking; TstL-taste liking; AftL-aftertaste liking; TxtL-texture liking; Sltl-salty intensity; Frmtl-fermented flavor intensity; Rchl-rich flavor intensity; ArtSsnl-artificial seasoning flavor intensity; Famlr-flavor familiarity.

²⁾TDJ-*Doenjang* made by traditional method, MDJ-*doenjang* made by commercially manufactured method, MCG-*cheonggukjang*, SCG-*saeng-cheonggukjang*, AMS-rice/barley-*koji miso*, WMS-rice-*koji miso*, NMS-soybean-*koji miso*, NTT-*natto*.

³⁾Mean values within the same column with the different alphabet differ significantly ($p < 0.05$).

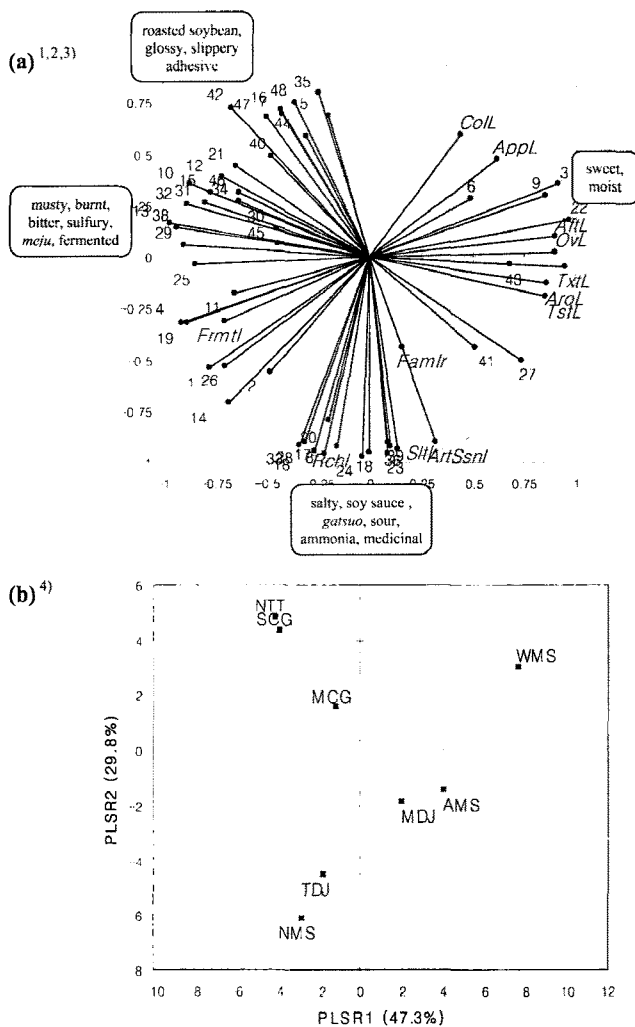


Fig. 1. PLSR loadings showing the relationship between the sensory attributes (X) and the consumer's liking and intensity perception (Y) of the fermented soybean samples (a) and the scores of product loadings (b).

¹⁾Regular font denotes the sensory attributes used in the descriptive analysis and *Italic* font denote the consumer's liking and intensity attributes. ²⁾1-Color intensity; 2-red; 3-yellow; 4-brown; 5-glossy; 6-moist; 7-sticky; 8-briny odor; 9-sweet odor; 10-burnt odor; 11-fermented odor; 12-dirty socks odor; 13-musty odor; 14-ammonia odor; 15-*meju* odor; 16-roasted soybean odor; 17-gatsuo odor; 18-soy sauce odor; 19-sulfury odor; 20-medicinal odor; 21-beany odor; 22-sweet; 23-salty; 24-sour; 25-bitter; 26-astringent; 27-MSG; 28-hot pepper; 29-burnt; 30-fermented; 31-dirty socks; 32-musty; 33-ammonia; 34-*meju*; 35-roasted soybean; 36-*gatsuo*; 37-soy sauce; 38-sulfury; 39-medicinal; 40-beany; 41-alcohol; 42-clear cut; 43-moist; 44-adhesive; 45-rough; 46-particle size; 47-mouth coat; 48-slippery. ³⁾OvL-Overall liking; AppL-appearance liking; ColL-color liking; AroL-aroma liking; TstL-taste liking; AftL-aftertaste liking; TxtL-texture liking; SltI-salty intensity; FmntI-fermented flavor intensity; Rchl-rich flavor intensity; ArtSsnI-artificial seasoning flavor intensity; FamI-flavor familiarity. ⁴⁾TDJ-*Doenjang* made by traditional method, MDJ-*doenjang* made by commercially manufactured method, MCG-*cheonggukjang*, SCG-*saeng-cheonggukjang*, AMS-rice/barley-*koji* miso, WMS-rice-*koji* miso, NMS-soybean-*koji* miso, NTT-*natto*.

of various fermented soybean products among the consumers participated in this study (Table 2). *Miso* was the next most frequently consumed fermented soybean

Table 2. The reported consumption frequencies of the various types of fermented soybean products

Frequency	<i>Doenjang</i> (%)	<i>Miso</i> (%)	<i>Cheonggukjang</i> (%)	<i>Natto</i> (%)
Daily	2.6	-	1.3	-
Once or more/week	69.7	7.9	5.3	-
Once or more/month	23.7	31.6	27.6	1.3
Once or more/3-4 month	1.3	32.9	25.0	5.3
Once or more/year	1.3	3.9	15.8	9.2
Never	1.3	23.7	25.0	84.2

product after *doenjang* among the consumers. *Cheonggukjang/natto* samples, which were one of the least preferred samples, were also rated low in the consumption frequencies. The relatively young age of the consumers may partly explain this results and implicitly reflecting the changes in the diet of young Korean consumers.

Identifying the critical sensory attributes affecting the acceptance of fermented soybean products The descriptive analysis data of the 8 fermented soybean samples were used in this study to understand the relationships between the sensory characteristics and the consumer perception of the various fermented soybean products. The detailed analysis of the sensory characteristics of the samples is described in Chung and Chung (37). When PLSR was conducted on the mean values of the descriptive data and the consumer data to identify the critical sensory attributes affecting the acceptance of fermented soybean products, liking in general showed strong positive correlation with the samples consisting of sweet and moist sensory characteristics (Fig. 1). Samples such as TDJ and NMS which were characterized as sour, salty, soy sauce, ammonia, richness, and artificial seasoning flavor but did not show any significant correlations with the consumer's acceptance ratings. *Cheonggukjang/natto* samples, which were characterized as raw bean, cooked bean, musty, and *meju* flavor, were loaded on the opposite direction of consumer's liking as well as perceived flavor intensity.

Effect of variety seeking tendency on acceptance for the fermented soybean products The variety seeking tendency of consumers did not significantly affect ($p > 0.05$) the acceptance or the perceived intensity ratings of the 8 fermented soybean products except for the overall liking of NMS sample and the rich flavor intensity of SCG sample (Table 3-1). Thus, the variety seeking tendency of a consumer was not an effective predictor for the acceptance of the products tasted in the experiment.

In the reported general liking, familiarity, and the frequency of consumption data, the high variety seekers significantly liked (Table 3-2, $p < 0.05$) and tend to eat *cheonggukjang* (data not shown, $p = 0.08$) more frequently than the low variety seekers. However, this reported preference for *cheonggukjang* was not exhibited in the actual taste testing data. It was shown in other studies that the measure of variety seeking tendency among consumers may be a good predictor for a reported dietary habit but have failed to show a significant effect on the preference or choice

Table 3-1. The mean overall liking and rich flavor intensity of the 8 fermented soybean products rated by the low and high levels of VST group

Sample	TDJ ¹⁾		MDJ		MCG		SCG		AMS		WMS		NMS		NTT	
	Low ²⁾ (n=35)	High (n=41)	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
OvL	4.4	4.3	5.6	6.0	4.9	4.9	4.0	4.3	5.6	6.0	5.6	5.9	4.8³⁾	3.1	4.1	3.9
Rchl	6.4	6.8	5.7	5.8	4.2	4.9	4.5	3.5	5.4	5.9	4.0	3.5	5.8	6.4	4.7	4.4

¹⁾TDJ-Doenjang made by traditional method, MDJ-doenjang made by commercially manufactured method, MCG-cheonggukjang, SCG-saeng-cheonggukjang, AMS-rice/barley-koji miso, WMS-rice-koji miso, NMS-soybean-koji miso, NTT-natto.

²⁾Denotes the number of consumers in each group.

³⁾Bold character denotes the significant difference between low and high VST group ($p < 0.05$).

Table 3-2. The reported mean liking and degree of familiarity on the various types of fermented soybean products among the consumers in the 2 levels of VST group

VST	Liking				Familiarity			
	Doenjang	Miso	Cheonggukjang ²⁾	Natto	Doenjang	Miso	Cheonggukjang	Natto
Low ¹⁾ (n=35)	4.4	3.2	2.7	1.8	4.7	3.3	3.3	1.6
High (n=41)	4.2	3.0	3.3	2.1	4.7	3.4	3.7	1.8

¹⁾Denotes the number of consumers in each group.

²⁾Bold character denotes the significant difference between low and high VST group ($p < 0.05$).

behavior in the actual consumer taste tests (11,12).

Understanding the consumer segments with common preferences for the fermented soybean products K-means cluster analysis, which was conducted to identify the sub-consumer segments sharing a relatively common preference pattern for the 8 fermented soybean products,

Table 4-1. The mean overall liking of the 8 fermented soybean products rated by the consumers in the 3 k-means cluster groups

Product	Group 1 ¹⁾ (n=28)	Group 2 (n=32)	Group 3 (n=16)
TDJ ²⁾	3.1a	4.9b	5.6cd
MDJ	5.2b	6.5c	5.8d
MCG	4.8b	4.7b	5.4bcd
SCG	5.2b	3.3a	4.0a
AMS	5.6bc	7.0c	3.8a
WMS	6.2c	6.6c	3.5a
NMS	3.0a	4.4b	4.3ab
NTT	5.0b	2.8a	4.5abc

¹⁾Denotes the number of consumers in each group.

²⁾TDJ-Doenjang made by traditional method, MDJ-doenjang made by commercially manufactured method, MCG-cheonggukjang, SCG-saeng-cheonggukjang, AMS-rice/barley-koji miso, WMS-rice-koji miso, NMS-soybean-koji miso, NTT-natto.

identified 3 significant consumer groups (Table 4-1). When the mean overall liking data of these 3 groups along with the descriptive analysis data were subjected to the EPM analysis, each group was defined as the following: Group 1 (n=28)-sweet, cooked bean, and musty flavor likers; Group 2 (n=32)-sweet and MSG flavor likers; Group 3 (n=16)-strong fermented flavor likers (Fig. 2).

Consumers in Group 1 not only preferred the sample WMS the most, which is characterized as sweet and moist, but also gave the highest rating for SCG and NTT among the 3 groups, which are characterized as cooked bean, burnt, and musty. Group 2 showed the characteristics of preferring samples (i.e., AMS, MDJ, and WMS) having strong sweetness as well as MSG flavor. Although the number of consumers in Group 3 was the fewest, this group had a distinctive preference for *doenjang* samples such as TDJ, MDJ, and *cheonggukjang* sample MCG. These samples showed relatively strong fermentation related flavors.

When the chi-square analysis was conducted to test whether the reported frequency of consumption data differ among the 3 groups, Group 1 and 2 significantly consumed *miso* more frequently than Group 3 (data not shown, $p = 0.05$). Additionally, Group 2 was significantly rated higher than Group 2 or 3 in reported *miso* familiarity and *doenjang* liking and familiarity (Table 4-2, $p < 0.05$). Group 3 was not

Table 4-2. The reported mean liking and degree of familiarity on the various types of fermented soybean products among the consumers in the 3 k-means cluster groups

K-mean clusters	Liking				Familiarity			
	Doenjang	Miso	Cheonggukjang	Natto	Doenjang	Miso	Cheonggukjang	Natto
1 ¹⁾ (n=28)	4.0a ²⁾	3.1	2.9	2.1	4.5a	3.5b	3.2	1.5
2 (n=32)	4.5b	3.2	3.0	1.8	4.9b	3.4b	3.6	1.7
3 (n=16)	4.3ab	2.8	3.3	2.2	4.6a	2.9a	3.6	1.9

¹⁾Denotes the number of consumers in each group.

²⁾Mean values within the same column with the different alphabets differ significantly ($p < 0.05$).

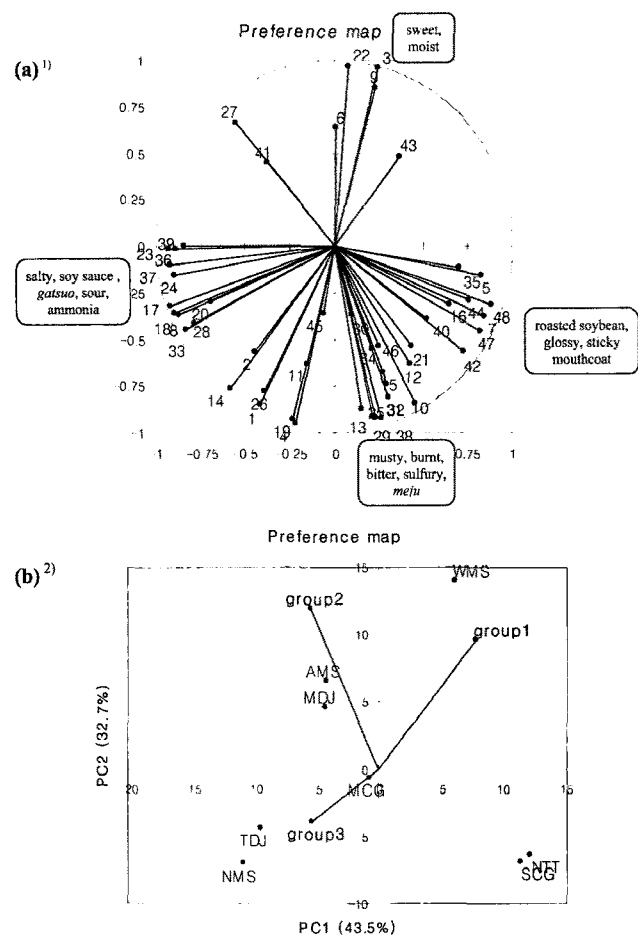


Fig. 2. PC loadings of the sensory attributes from the descriptive analysis data set (a) and the EPM showing the loadings of the 8 fermented soybean products and preference direction of the 3 k-means clustered groups (b).

¹⁾1-Color intensity; 2-red; 3-yellow; 4-brown; 5-glossy; 6-moist; 7-sticky; 8-briny odor; 9-sweet odor; 10-burnt odor; 11-fermented odor; 12-dirty socks odor; 13-musty odor; 14-ammonia odor; 15-meju odor; 16-roasted soybean odor; 17-gatsuo odor; 18-soy sauce odor; 19-sulfury odor; 20-medicinal odor; 21-beany odor; 22-sweet; 23-salty; 24-sour; 25-bitter; 26-astringent; 27-MSG; 28-hot pepper; 29-burnt; 30-fermented; 31-dirty socks; 32-musty; 33-ammonia; 34-meju; 35-roasted soybean; 36-gatsuo; 37-soy sauce; 38-sulfury; 39-medicinal; 40-beany; 41-alcohol; 42-clear cut; 43-moist; 44-adhesive; 45-rough; 46-particle size; 47-mouth coat; 48-slippery. ²⁾TDJ-Doenjang made by traditional method, MDJ-doenjang made by commercially manufactured method, MCG-cheonggukjang, SCG-saeng-cheonggukjang, AMS-rice/barley-koji miso, WMS-rice-koji miso, NMS-soybean-koji miso, NTT-natto.

as familiar with *miso* as Group 1 or 2 ($p < 0.05$). Thus, the consumers in different groups somewhat differed in the consumption frequency, acceptance, and familiarity of various fermented soybean products.

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