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Journal

Food Science and Biotechnology, 25(3)

ISSN

1226-7708

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Publication Date

2016-06-01

DOI

10.1007/s10068-016-0128-1

Peer reviewed

Food Sci. Biotechnol. 25(3): 745-756 (2016)
DOI 10.1007/s10068-016-0128-1

Food Science and Biotechnology

Exploration of Flavor Familiarity Effect in Korean and US Consumers' Hot Sauces Perceptions

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Received December 10, 2015
Revised February 4, 2016
Accepted March 3, 2016
Published online June 30, 2016

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pISSN 1226-7708
eISSN 2092-6456

Abstract The present work explored how consumers' product perceptions differ when flavor familiarity with the product set varied. Half of the samples used in this study contained fermented ingredients (fermented red pepper or *gochujang*, a traditional Korean fermented soybean/red pepper paste), and the others were top selling hot sauce products in the US market. Free-choice profiling was performed by Korean and US consumers and was analyzed using GPA. Descriptive analysis was conducted and analyzed using PCA. While Korean and US consumers perceived product similarly along the first principal dimension which described distinctive sensory differences among the products, in the next principal dimension, it was found that these consumers perceived the products differently. Observations indicated that this discrepancy seemed to be originated from differences in flavor familiarity. This study showed flavor familiarity not only influences one's preference but also may influence perception of foods such as hot sauces.

Keywords: flavor familiarity, cross-cultural research, product perception, free-choice profiling, hot sauce

Introduction

Various cross-cultural studies have been conducted and the importance of 'familiarity' in the construction of preference has been reported in several cross-cultural studies (1-9). In studies by Laing *et al.* (7) and Prescott *et al.* (4,5), the likings of Japanese and Australians for sweetness, saltiness, sourness and bitterness differed, with higher preference shown for domestically available products than for unfamiliar international products. Also, Pagés *et al.* (2) reported higher overall liking scores for biscuits that were domestically produced than for those from other countries. Chung *et al.* (1) and Choi *et al.* (3), who compared the likings of Korean and US consumers for Korean-style salad dressing and beverages, and for Korean-style barbecue sauce, respectively, reported that familiarity with the sensory characteristic was one of the main factors that influenced likings by the consumers. In addition, in the study of Hong *et al.* (9), it was found that familiarity was an important cue that contributed to foreign consumers' (Japanese and French) hedonic ratings for a traditional Korean sweet treat (*Yackwa*).

Recent cross-cultural studies, which investigated about consumers' perceptions of product differences, have shown hints of 'familiarity' playing an important role in how consumers perceive product differences (10,11). Blancher *et al.* (10) observed that when sorting or flash profiling was conducted on jelly samples that were commercially available in Vietnam, strategies to characterize (sort or rank) the samples were much more in common among Vietnamese consumers, while French consumers differed among each other. Kim *et al.* (11) compared the perceptions of Korean and French consumers for various green tea products using the Napping® procedure. The study found that Korean consumers, who were familiar with green tea, were able to differentiate green teas based on their manufacturing process and country of origin, whereas the French consumers, who did not have a tradition of drinking green teas and thus were unfamiliar with them, only differentiated the products based on their hedonic dimension. Overall, these studies support the hypothesis that familiarity is a key factor not just in the liking for a product, but also in the construction of how consumers perceive the products' sensory differences.

For the introduction of profiling techniques that can be used by consumer subjects such as free-choice profiling (FCP), sorting, projective mapping or Napping®, and check-all-that-apply questionnaires, researchers have been able to investigate and understand how consumers perceive sensory characteristics differently among various products (12). These techniques have revealed the main criteria that consumers use to conceive the sensory space for the product, which can be somewhat different from those that are used by trained panelists. Hence, these consumer-based profiling techniques can aid in understanding the target consumer's perception of

products, and can furthermore be useful in cross-cultural comparison studies.

FCP is one of various consumer-based sensory profiling techniques that allow individual subjects to use a personalized list of terms to describe the differences among the product set (13). Unlike traditional descriptive analysis, FCP does not call for agreement in the interpretation of the terms used to describe sensory differences among products (14). The terminology that each assessor develops may vary, depending on the panelist's individual experiences and familiarity with the product (15). Like other consumer-based profiling techniques, the FCP technique can provide insight into how consumers differ in their perceptions of the differences among products and the key features used for differentiating them (16). Also, unique language used by consumers can be understood by using FCP, a benefit not gained from trained judges in descriptive analysis (17).

The aim of the present work was to investigate differences in the cross-cultural perceptions of people with different cultural backgrounds and ethnic origins when the level of flavor familiarity within the sample set differed. Previous studies (10,11) that aimed to investigate the influence of familiarity in product perception selected samples that were familiar to one culture, but unfamiliar to the other. Hence these studies were effective in showing the role of familiarity in product perception in a cross-cultural context; however, limitations also existed in understanding the perception differences of consumers when familiarity with the product set varied. In reality, novel ethnic flavors will be compared with existing flavors in the market that are familiar to people of the target culture. Therefore, the authors of this study believe that it is important to investigate cross-cultural perceptual differences when the level of flavor familiarity within the sample set varies.

Materials and Methods

Samples For the purpose of this research, hot sauces were selected as the product of interest, because hot sauces are widely used in various cultures, and because the popularity of spicy foods is increasing worldwide (18,19). In order to investigate the effect of familiarity on perceptions, a design was considered where half of the samples were expected to be familiar to one group of consumers from one culture, while the other half were expected to be familiar to the group of consumers from the other culture.

Four hot sauces differing in their main ingredients were selected as samples. Half were thought to be more familiar to Koreans and the other half to be more familiar to US consumers. The former two samples, GB and FPB, were made using fermented ingredients, such as *gochujang* (traditional Korean fermented soybean/red pepper paste) and red pepper that was fermented using lactic acid bacteria, as the main ingredients. These two samples were expected to be familiar to Korean consumers because of Korean's long tradition of consuming *gochujang* as well as Kimchi which is a product that is based on a lactic acid fermentation of vegetables (Chinese cabbage, chili peppers, radish etc.). The main ingredients for GB were *gochujang*, isomalto-oligosaccharides, vinegar, and sucrose, and for FPB were fermented red peppers, isomalto-oligosaccharides, vinegar, red peppers, and sucrose. The latter two samples, TAB and SRI, were two of the most popular hot sauces sold in the US. TAB and SRI are manufactured in the US. The main ingredients for TAB were red chili peppers, vinegar and refined salt, and for SRI were chili pepper, sucrose, salt, garlic and vinegar. It should be noted that the samples were selected to be very different in their characteristics that are easily distinguishable from each other. Because of the lingering pungency of the hot sauces, only four samples were included in the design.

Descriptive analysis

***Panel selection and training*:** Descriptive analysis was performed using 8 trained panelists (aged 23-38, 8 females) who were students of Ewha Womans University (Seoul, South Korea). During the training, the panel generated sensory descriptors for the hot sauces, and then defined and selected appropriate references for each sensory descriptor (Table 1). The training continued until the panel reached consensus for each term and was able to reproduce their ratings. Training sessions were held 3 times per week for a month and each session lasted approximately 90 min.

***Sample preparation and presentation*:** Five milliliters of each sample was poured into amber glass vials (10 mL) coded with 3-digit random numbers. The samples were served and evaluated at room temperature (20±2°C) and the presentation order of the samples was randomized for each judge. For appearance evaluation, a new set of samples was prepared in transparent glass vials (20 mL) with new random numbers. Each panelist was provided with filtered (filtered tap water; Ceramic Filter System, Supercape, Dalton, Fariey Industrial Ceramics Ltd., London, UK) warm water (45±2°C) and a cup of whipping cream (un-whipped, 8±2°C) (Excellence Whipping Cream, ELVIR Co., Condé-sur-Vire, France) for palate cleansing. Because it has been reported that a higher level of fat is more efficient in improving subjects' discrimination ability for spicy foods (18), whipping cream was chosen as a palate cleanser in the study.

***Evaluation procedure*:** A quantitative descriptive analysis (QDA®) procedure was used to characterize the sensory attributes of the hot sauce samples. Panelists were asked to scoop each sample using the provided stainless steel spoon (diameter 1.5 cm) to taste the sample. For samples that were thick and viscous, the panelists were instructed to wipe off the back of the spoon to ensure that the panelists tasted similar amounts of the samples. Each scoop contained approximately 0.1 mL of each sample. After tasting the samples, the panelists evaluated the intensities of the sensory attributes. After finishing each sample, the subjects were asked to cleanse their palate by first using warm water (45±2°C) to remove the remaining hot sauce samples, followed by rinsing with whipping cream. Then subjects

Table 1. Definitions and references for the sensory attributes of the hot sauces

	Sensory attributes	Definition	Reference samples
A[1)]	Redness	Intensity of orange-red color of sauce	Color strip (Dainippon Ink and Chemicals Co., Tokyo, Japan) Weak (point 1) - #120; Strong (point 15) - #198
	Darkness	Intensity of darkness of sauce	Color strip(Dainippon Ink and Chemicals Co.) Weak (point 1) - #583; Strong (point 15) - #582
	Non-uniformity	Non-uniformity of the particle size in the glass wall after shaking sauce	1 g of dried red pepper powder in fine particles (Daesang FNF Corp., Yeongwol, Korea) mixed with 1 g of dried red pepper powder in coarse particles (Myungam Corp., Jecheon, Korea)
	Particle	Intensity of quantity of particle in the glass wall after shaking sauce	1 g of dried red pepper powder (Daesang FNF Corp.)
	Viscosity	Amount of effort required to flow sauce when tilting the glass	0.33 mL of rice syrup (Daesang Co., Osan, Korea)
F	Sweet taste	Fundamental taste sensation of which sucrose is typical	6.11% sucrose (Duksan Pure Chemical Co., Ltd., Ansan, Korea) solution
	Salty taste	Fundamental taste sensation of which sodium chloride is typical	0.59% NaCl (Duksan Pure Chemical Co., Ltd.) solution
	Sour taste	Fundamental taste sensation of which citric acid is typical	0.1% citric acid (Duksan Pure Chemical Co., Ltd.) solution
	Bitter taste	Fundamental taste sensation of which caffeine is typical	0.05% caffeine (Duksan Pure Chemical Co., Ltd.) solution
	MSG taste	Fundamental taste sensation of which monosodium glutamate is typical	1% MSG (Duksan Pure Chemical Co., Ltd.) solution
	Vinegar	Aromatics associated with *yangjo* vinegar	2 g of *yangjo* vinegar (Daesang FNF Corp.) mixed with 10 mL sauce[2)]
	Chili pepper	Aromatics associated with red chili pepper	2 g of chopped red chilli mixed with 10 mL distilled water
	Bell pepper	Aromatics associated with cooked green bell pepper	10 g of chopped green bell pepper cooked at low heat for 1 min 30 s
	Dried chili pepper powder	Aromatics associated with dried chili pepper powder	2 g of dried chili pepper powder (Daesang FNF Corp.) mixed with 10 mL sauce[2)]
	Gochujang	Aromatics associated with *gochujang*	10 g of *Gochujang* (CJ Cheiljedang Corp., Nonsan, Korea) mixed with 10 mL sauce[2)]
	Cooked tomato	Aromatics associated with cooked tomato	10 g of whole tomato (Hunt's whole peeled tomato, Conagra Foods, Omaha, NE, USA) cooked at medium heat for 15 min, then mixed with 10 mL sauce[2)]
	Traditional Korean soy sauce	Aromatics associated with musty flavor of traditional Korean soy sauce	4 g of soy sauce (SempioChoseon soy sauce, Icheon, Korea) mixed with 10 mL sauce[2)]
	Garlic	Aromatics associated with cooked garlic	0.5 g of chopped garlic (Gana Corp., Suwon, Korea) cooked at low heat for 1 min 30 s, then mixed with 10 mL sauce[2)]
	Onion	Aromatics associated with onion	1 g of chopped onion mixed with 10 mL sauce[2)]
	Smoky	Aromatics associated with smoky	Liquid smoke (Wright's Hickory Seasoning Liquid Smoke, B&G Food Inc., Parsippany-Troy Hills, NJ, USA)
	Mustard	Aromatics associated with mustard	1 g of mustard (Daesang FNF Corp.) mixed with 10 mL sauce[2)]
M	Pungent	The sharp physically penetrating sensation in the nasal cavity after swallowing	1 g of mustard (Daesang FNF Corp.) mixed with 10 mL sauce[2)]
	Burning	Chemical burning sensation on the tongue or in the mouth	*Gochujang* (CJ Cheiljedang Corp.)
T	Chalky (Residual)	The perception of small particles distributed within the sauce	1 g of corn starch (Jeonwon Foods Co., Kimpo, Korea) mixed with 10 mL of sauce[2)]

[1)]A, Appearance; F, Flavor; M, Mouthfeel; T, Texture
[2)]Sauce is made by mixing all 4 hot sauce samples in same quantities (volume).

were asked to rinse once again using warm water to remove the remaining whipping cream in their mouth. After the panelist was done with the evaluation of one sample, he or she was instructed to take a 3-min break before testing the next sample, so as to minimize the lingering effect of the burning sensation.

Flavor and mouthfeel attributes were evaluated first in a monadic sequence and appearance attributes were examined at the end. All sensory attributes were evaluated on a 16-point category scale, from "none (0)" to "strong (15)". The evaluation of flavor and mouthfeel attributes was conducted in an isolated booth under a dim red light, so as to avoid any biases that might occur from color differences in the samples. For appearance evaluation, samples were placed in a light box (Superlight-III; Boteck, Siheong, Korea) under a daylight condition (D65). Each evaluation session took approximately 30 min to complete, and the test was repeated 4 times over 2 days.

Consumer test using free-choice profiling

***Selection of the consumers*:** Consumers who self-reported oneself to enjoy eating spicy foods as well as adding hot sauce to some of their dishes and to consume spicy foods more than once in every 2 weeks were selected as participants of the study. Also, consumers were people who did not have any experiences in descriptive analysis and who did not have any food related allergies reported. A total of 14 Korean consumers (aged from 18-35; 14 females) and 14 US (aged from 26-65; 5 males and 9 females) consumers participated in the FCP study for hot sauces. In addition, among the various ethnicities comprising US citizens, only those of Caucasian descent were invited as consumers for the FCP study at the US site (Davis, CA, USA). This was because Caucasians do not have a strong cultural tradition of eating spicy foods compared to other major ethnicities in the US such as Hispanics/Latinos or Asians. In addition, because latively small number of consumers participated at each site, ethnicity was restricted to one ethnic group to ensure homogeneity in their cultural background. All recruitment was performed using flyers and through email listservs.

***Sample preparation and presentation*:** Aliquots of samples (5 mL) were poured into transparent plastic cups (30 mL, Easepack Co., Namyangju, Korea) coded with 3-digit random numbers. The samples were served and evaluated at room temperature (20±2°C) and the presentation order of the samples was randomized for each subject. Each panelist was provided with filtered (filtered tap water; Ceramic Filter System, Supercape, Dalton, Fariey Industrial Ceramics Ltd.) warm water (45±2°C) and a cup of whipping cream (un-whipped, 8±2°C) (Excellence Whipping Cream, ELVIR Co.) for palate cleansing.

***Evaluation procedure*:** FCP was conducted at two sites: Ewha Womans University (Seoul, South Korea) for the Korean consumers and University of California, Davis (CA, USA) for the US consumers. The study consisted of 5 sessions in total at each site. The first two sessions were score sheet development sessions, and the last three sessions were for data collection. In the first session, consumers were first briefed on the concept behind the technique, and were then asked to generate terminologies to describe the differences in the four provided hot sauce samples using their own words after tasting each sample. For better development of the terminologies, 4 modality categories (appearance, aroma, taste/flavor and mouthfeel/texture) were given to consumers. In the second session, each individual's lists of terms developed in the first session was reviewed individually, and each consumer was given the opportunity to refine the terms as well as to remove redundancies if necessary. Based on the individual descriptors, a personal list of terms was developed. Then, a practice session was conducted using the personalized score sheet. Panelists were placed in individual booths, and were given 4 hot sauce samples to practice evaluation. Note that the practice session was designed to allow consumers to become familiar with the evaluation protocols. In the last 3 sessions, actual evaluation was conducted. Each panelist used their own list of terminologies to evaluate the product. Tasting of the samples consisted of scooping the sample using the provided stainless steel spoon (diameter 1.3 cm, fluid volume 0.3 mL). Note that consumers were instructed to taste the samples as much as and as many times as they wanted to. However, they were warned to start off with smaller amounts so that the burning sensation would not overwhelm the participants during the evaluation. After tasting the sample, the intensities of the developed attributes were rated on a 16-point category scale, from "none (0)", "weak (1)" to "strong (15)". Samples were evaluated monadically. After completing the evaluation of one sample, the subjects were asked to cleanse their palates using the same procedure that was used in descriptive analysis. The evaluation was conducted in an isolated booth under fluorescent lighting. Each session took approximately 60 min to complete. The study was approved by the Institutional Review Board (IRB) at Ewha Womans University, Seoul, South Korea (#69-9) and at the University of California, Davis, CA, USA (#59120-1).

Statistical analysis On the descriptive analysis data, analysis of variance (ANOVA) was conducted, and the sample means were compared for each attribute using Duncan's multiple range test (α=0.05). Principal component analysis was carried out on the descriptive data averaged across panelists for each product tested at each replication (a total of 16 observations were included in PCA), in order to graphically summarize the characteristics of the 4 tested samples as well as to determine the robustness of the panel performance.

FCP data were analyzed using the Generalized Procrustes Analysis (GPA) method (20,21), which can allow rationalization of the spatial configurations derived from individual profiles (13). Before employing GPA, data from the 3 sessions for each assessor were averaged. Terms were organized using the same approach employed in the study by Guàrdia *et al.* (14) with modifications. First, individual terms generated by each consumer with a correlation coefficient higher or equal to 0.70 or 0.60 to dimension 1 or 2 of the obtained GPA

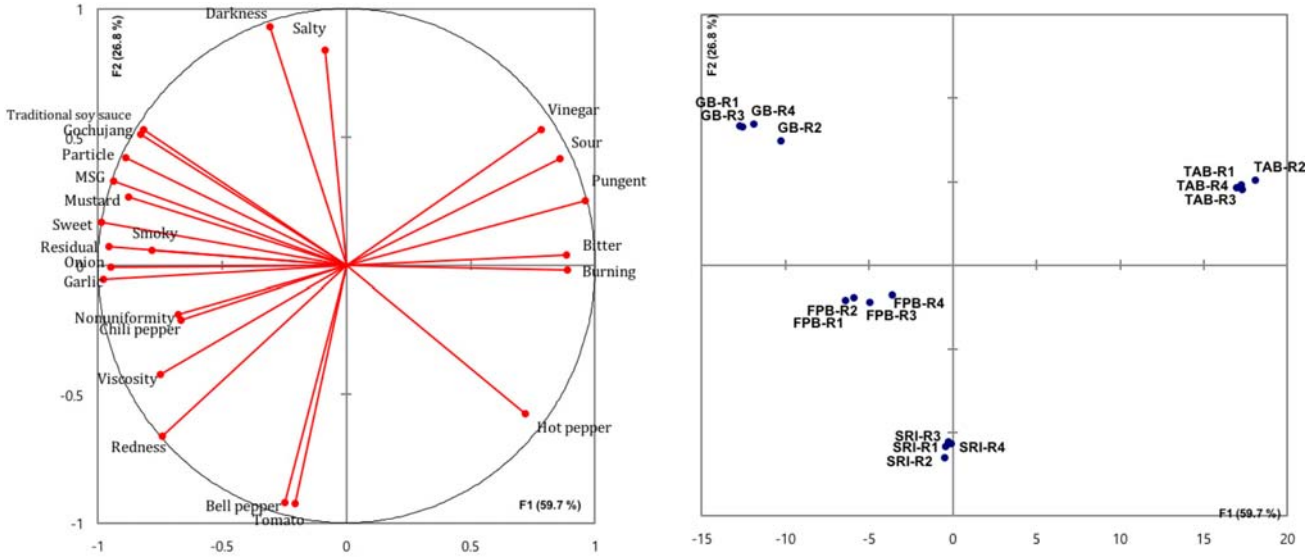

Fig. 1. PC loadings of the sensory attributes and 4 hot sauce samples on the first two PC dimensions. R1, 1st replication; R2, 2nd replication; R3, 3rd replication; R4, 4th replication

consensus configuration, respectively, were selected. Then, these terms were semantically grouped together with other terms that had similar meaning, and the frequencies of the groups were counted. Terminology groups that were used by at least 20% of each consumer panel were selected for interpretation of the GPA configuration. In the GPA consensus map, the font size for the descriptors was shown to be proportional to the relative frequencies of elicitation (14). All statistical analyses were conducted using XLSTAT 14.0 for windows (Addinsoft, Paris, France).

Results and Discussion

Sensory characteristics of hot sauces using descriptive analysis

From descriptive analysis, 24 sensory descriptors were generated for the 4 hot sauce samples (Table 1). ANOVA results showed that the intensities of all sensory attributes differed significantly (p<0.05) among the samples. The PCA results showed that the first two principal components (PCs) explained 59.68% and 26.76% of the total variance, respectively (Fig. 1). In addition, it was shown that the same samples that were evaluated in different sessions were located close together, which indicated that the panel evaluated the differences of the samples consistently throughout the evaluations. As shown in Fig. 1, the descriptive panelists mainly differentiated between the TAB sample and the rest of the other samples along the PC 1 dimension. TAB was highly loaded on the positive PC 1, and was shown to have relatively stronger "sour taste", "bitter taste", "vinegar", and "chili pepper" flavors and "pungent" and "burning" mouthfeel characteristics, which mainly defined positive PC 1 (Fig. 1). On the other hand, the rest of the samples were located on the negative PC 1, and were shown to have stronger intensities of "redness", "particle", "non-uniformity", and "viscosity" in appearance, as well as "sweet", "MSG", "*gochujang*", "traditional soy sauce", "mustard", "smoky", "onion", "garlic", and "red pepper" flavors, and "residual" mouthfeel characteristics, which mainly defined negative PC 1 (Fig. 1). Unlike TAB, samples FPB, GB, and SRI included sweetening agents such as isomalto-oligosaccharides or sucrose, whereas there was no sweetener in TAB. It is well known that sweetness can suppress sour taste (22-24). Hence, the addition of sweeteners seemed to be responsible for the lower intensities of sourness and sharp notes that can originate from the use of vinegar in FPB, GB, and SRI.

The next PC further differentiated samples FPB, GB, and SRI. Sample SRI was positioned on the negative PC 2, and was mainly characterized by "redness" and "viscosity" in appearance, in addition to "chili pepper", "bell pepper", and "cooked tomato" flavors. It also had the 2nd highest "burning" sensation (Fig. 1 and Table 2). Sample FPB was located in the middle of PC 2, and was mainly characterized by "redness", "non-uniformity", "particle", "dried chili pepper powder", "garlic", and "onion" characteristics (Fig. 1 and Table 2). Lastly, sample GB was highly loaded on the positive PC 2 direction. Thus, the samples were located on the 2nd quadrant of the PCA plot that was mainly characterized by "darkness", "particle", and "viscosity" in appearance, "sweet taste", "salty taste", "MSG taste", "*gochujang*", "traditional soy sauce", "garlic" "onion", "smoky", and "mustard" flavors, and "chalky (residual)" mouthfeel (Fig. 1 and Table 2). The GB sample contained *gochujang* as one of the main ingredients. *Gochujang* is a traditional Korean fermented soybean/red pepper paste made from red chili, glutinous rice, *meju* (dried fermented soybeans) and salt (25). Because of the use of *meju*, which is made by fermenting soybeans with *Bacillus subtilis* and its relatives (26,27), as an ingredient of *gochujang*, *gochujang* has a signature aroma and

Table 2. Mean intensity scores for sensory attributes[1)] of hot sauce samples

Sensory attributes		Samples			
		GB	FPB	TAB	SRI
Appearance	Redness	8.06^{c}	10.09^{b}	1.66^{d}	11.66^{a}
	Darkness	12.69^{a}	5.59^{c}	7.50^{b}	2.53^{d}
	Nonuniformity	6.69^{b}	11.97^{a}	2.44^{d}	5.66^{c}
	Particle	11.59^{a}	9.16^{b}	3.66^{d}	4.97^{c}
	Viscosity	9.41^{b}	5.62^{c}	1.69^{d}	10.72^{a}
Flavor	Sweet taste	9.69^{a}	7.09^{b}	1.06^{d}	4.97^{c}
	Salty taste	11.34^{a}	5.75^{c}	9.09^{b}	6.16^{c}
	Sour taste	5.78^{c}	7.56^{b}	12.47^{a}	5.16^{c}
	Bitter taste	4.78^{c}	3.34^{d}	9.97^{a}	7.03^{b}
	MSG taste	9.69^{a}	6.28^{b}	1.44^{d}	4.03^{c}
	Vinegar	6.72^{b}	7.44^{b}	11.37^{a}	5.38^{c}
	Chili pepper	3.25^{c}	4.47^{b}	7.69^{a}	8.31^{a}
	Bell pepper	2.75^{c}	3.91^{b}	1.88^{d}	8.44^{a}
	Dried chili pepper powder	5.59^{b}	7.47^{a}	3.59^{c}	5.28^{b}
	Gochujang	8.63^{a}	3.50^{b}	0.84^{d}	2.13^{c}
	Cooked tomato	2.03^{c}	3.53^{b}	0.69^{d}	8.88^{a}
	Traditional Korean soy sauce	9.31^{a}	3.50^{b}	0.75^{d}	2.00^{c}
	Garlic	4.56^{a}	4.25^{a}	1.28^{c}	3.37^{b}
	Onion	5.97^{a}	6.13^{a}	1.19^{d}	3.88^{b}
	Smoky	8.31^{a}	2.59^{c}	1.03^{d}	5.72^{b}
	Mustard	7.50^{a}	4.06^{b}	2.03^{c}	4.31^{b}
Mouthfeel	Pungent	3.44^{c}	3.59^{c}	11.84^{a}	4.72^{b}
	Burning	5.53^{c}	3.78^{d}	12.75^{a}	9.16^{b}
Texture	Chalky (Residual)	7.13^{a}	5.34^{b}	1.69^{c}	4.66^{b}

[1)]Means of 4 replicates from the 8 panelists: mean values within a row not sharing a superscript letter are significantly different (p<0.05, Duncan's multiple range test)

flavor characteristics that are described as "soy sauce", "*meju*", "fermentation" (28). In the results of descriptive analysis in this study (Fig. 1 and Table 2), the higher intensity of "traditional soy sauce" flavor also seemed to explain the particular sensory profile derived from fermented soybean, since traditional Korean soy sauce is made by fermenting the mix of *meju*, salt and water (29).

Comparison of perceptual differences of hot sauces between Korean and US consumers

***Frequently elicited descriptors describing hot sauces*:** Koreans who went through FCP used 16.5 attributes on average, and the number of attributes they used to describe the differences among the hot sauce samples ranged from 10 to 30. US consumers used 17.8 attributes on average, with a range from 8 to 27 attributes. On the other hand, in other studies that compared the perceptions of consumers from two different cultures using other consumer-oriented profiling techniques such as flash profiling or Napping®, bigger differences were found in the number of descriptions elicited from consumers with different cultural backgrounds (10,11). Unlike these studies, which used samples that were more familiar to one panel than the other, not much difference was observed in the number of descriptors elicited between Korean and US consumers in the present study. It is assumed that because consumers participated in this study were all frequent hot sauce users, participants were all familiar to the products category though flavor familiarity within the set may have varied.

Table 3 summarize the frequencies of frequently elicited (>20%) descriptors for each consumer group. When the major descriptors (i.e. elicited from 50% or more of the whole panel) were compared, the Korean panel used the terms "thick appearance (or watery appearance)", "redness", "darkness", "sweet aroma", "spicy aroma", "*gochujang* aroma", "acidic aroma", "sweetness", "sourness", "spiciness", "saltiness", "acidic", and "thickness mouthfeel" to describe the differences among the samples. On the other hand, more than 50% of the US consumers used the terms "redness", "thick appearance", "brownness", "cloudiness (or clarity)", "vinegary aroma", "sweetness", "spiciness/heat", "vinegary" and "thickness (or thinness) mouthfeel". Hence, the key features of the hot sauce samples were similar for the two countries, except for the term "*gochujang* aroma" used by Korean consumers. It is known that odor or flavor judgments are generally influenced by experience with that particular odor or flavor source (30). As *gochujang* is one of the most important ingredients in Korean cuisine, the odor/flavor should have been distinct for Korean subjects, while US consumers would use different words to describe the same characteristic or would omit describing it. However, overall, most of the major descriptors between the two countries shared similar semantic meanings. As stated by Guàrdia *et al.* (14), the main FCP terms elicited from consumers can be either descriptors that are important cues for the product category itself or terms that are easy to elicit due to easily noticeable differences.

***Cross-cultural comparison of perceptual configurations of hot sauces*:** Figures 2 and 3 show the consensus configuration obtained from GPA using FCP data from Korean consumers and US consumers, respectively. The first two consensus dimensions accounted for 90.13 and 88.82% of the variability in the Korean and US FCP data, respectively. Each dot within each product represents individual consumers describing the same product. As can be seen in Fig. 2 and 3, individual dots were concentrated within each product, which means that both panels were internally in agreement for their perceptions of the 4 hot sauce samples. This observation was expected as the samples were chosen to be very different in their sensory characteristics.

The biggest difference among the 4 hot sauce samples detected by Korean consumers was between sample TAB and the rest of the other samples according to the first dimension (Fig. 2). Similar to the Korean consumers, the biggest difference perceived by US consumers was between sample TAB and the rest of the samples (Fig. 3). This was consistent with the sample differentiation from descriptive analysis, which showed a separation between TAB and the rest of the samples (Fig. 1). In addition, when the descriptions of TAB were compared between Korean and US consumers as well as the trained

Table 3. Frequency of elicited descriptors (>20%) of hot sauces from Korean and US consumers

	Korean consumers			US consumers		
	Attribute	Original words (in Korean)	Freq. (%)	Attribute	Original words	Freq. (%)
A[1)]	Thickness (opposite: Watery appearance)	점도, 묽음-걸쭉함, 점성(묽은-되직), 점성 Opposite terms: 묽은 정도, 묽음(진한-묽은), 묽기	85.7	Redness	Color (yellow-red), red, red intensity, red (orange-red), color (orange-red), orangey red color	69.2
	Darkness (opposite: Brightness)	어두운 정도, 색(밝은-어두운 색), 밝은-어두운 색, 빨간색의 어두운 정도, 주황빛-붉음-검붉음, 색상의 진한 정도(주홍-빨강-검붉은) Opposite terms: 명도	57.1	Thickness	Thickness, thickness (thin-thick), viscosity (runny-thick), structure (liquid-dense), clarity (thin-thick)	61.5
	Redness	빨강, 빨강 (채도), 붉은색, 색의 붉은 정도(노랑-주황-빨강), 색(노란색-붉은색), 주황-다홍-빨강, 붉기, 붉음	57.1	Brownness	Brown intensity, brown (red-brown), brown component (red-brown), reddish brown color, brown, red to brown, degree of reddish red (light red-dark red)	53.8
	Particle density	입자의 밀도, 고추가루 입자, 가루같은 내용물이 보임, 외관상 보이는 알갱이(고춧가루), 입자	35.7	Cloudiness (opposite: Clarity)	Cloudiness (clean-cloudy), cloudy, opacity (clear-opaque), transparency (clear-opaque), clarity (clear to opaque), clarity (thin-thick) Opposite terms: Ability to see through liquid	53.8
	Particle size	입자크기, 가루의 크기, 고춧가루 입자크기, 다진 마늘 입자, 고춧가루 입자크기	28.6	Graininess	Dots, grain size, graininess	30.8
	Vividness	선명함, 색이 진한 정도 (연함-진함), 색(옅다-진하다), 붉은색의 진한 정도	28.6	Orangeness	Orange, orange intensity, orange component (red-orange)	30.8
	Clarity (opposite: Opaque)	투명도, 멀겋다, 투명도(투명-불투명) Opposite terms: 탁도 (탁함의 정도)	28.6	Darkness (opposite: Brightness)	Darkness (white-black), darkness (light-dark) Opposite terms: Brightness	30.8
O	Sweet aroma	달콤한 향, 단향, 달짝지근한 향, 달달한 향, 단내	64.3	Vinegary	Vinegar, vinegary	61.5
	Spicy	매운향, 매콤한 향, 매운향/고춧가루향	57.1	Peppery	Chili pepper, pepper, peppery, peppery (no pepper-peppery), pepper powder	46.2
	Gochujang	고추장향, 고추장	57.1	Sweetness	Sweet, sweetness (sweet-dry)	38.5
	Acidic	시큼한 향, 시큼함, 신향	57.1	Odor intensity	Degree of scent (unscented-scented), intensity, odor strength (mild-strong), scented	30.8
	Pungent/Stinging	톡 쏘는 향, 코를 찌르는 향/얼얼한 정도, 코끝을 쏘는 향, 톡 쏘는 향/식초향	28.6	Smoky	Smoky, smokiness (none to intense), smoked	30.8
	Vinegary	식초향	21.4	Tangy/Acidic	Tangy, Tanginess (not tangy/no vinegar-tangy/vinegar), acidic, sourness (not sour-sour)	30.8
	Citric/Sour	새코한 향, 새콤함(레몬즙, 감귤즙), 상큼한 향	21.4	Soy	Soy, edamame	23.1
				Tomato	Tomato	23.1

Table 3. Continued

	Korean consumers			US consumers		
	Attribute	Original words (in Korean)	Freq. (%)	Attribute	Original words	Freq. (%)
F	Sweetness	달콤함 맛, 단맛, 달달하다/달다	85.7	Spicy/Heat	Spiciness flavor, fire, spicy, heat, spicy-overall, heat (none-intense), spicy (no spicy-spicy), hot	92.3
	Spicy	매운맛, 매운 정도	78.6	Sweetness	Sweetness (no sweet-sweet), sweet, sweetness, sweetness (none-intense)	92.3
	Sourness	신맛	78.6	Vinegary	Vinegar flavor, vinegar, tangy/acidic/vinegar, acid, vinegary (no vinegar-vinegary)	61.5
	Saltiness	짠맛	57.1	Smokiness	Smoke, smokiness, smoked, smokiness (non-smoking flavor-smoking flavor)	46.2
	Acidic	시큼한 향, 김치의 끝맛, 시큼함(고추장아찌), 시큼한 맛(식초맛), 끝맛이 시큼, 시큼새큼한 맛	50.0	Sourness	Sour, Sourness	38.5
	MSG taste	조미료 맛(인위적인 맛), 인공적인 맛, 감칠맛, 조미성분 맛/깻잎 향미	35.7	Saltiness	Salt, salty	38.5
				Peppery	Pepper, Peppery (no pepper-peppery), red chili flavor	23.1
				Garlic	Garlic, garlic taste (none-intense)	23.1
				Fruity	Fruity, fruit	23.1
T	Thickness (opposite: thinness)	점성, 젤라틴을 물에 녹인듯한 텍스처 (푸딩), 끈적거리는 정도, 흐르는 수준(물같은-되직), 물같은-된 Opposite terms: 물같은 텍스처, 묽음, 묽음(진한-묽은), 묽기, 묽은 정도	85.7	Thickness (opposite: Thinness)	Consistency (thin-thick), thickness, thickness (in mouth), thickness (water-hoisin), denseness Opposite terms: liquid, thinness texture	61.5
	Chunkiness/ Chewiness of particles	과육의 씹힘, 이물질이 느껴지는 텍스처, 입자의 굵은 정도(입자씹힘), 고체의 비율(적음-많음), 씹히는 맛(고추가루x), 알갱이	42.9	Chunkiness/Lumpiness	Lumpiness, chunkiness, granularity (-large), smoothness (smooth-chunky), smoothness	46.2
	Smooth	부드러운 느낌, 부드러움, 입자들이 고루 섞인(거친-부드러운)	21.4	Burning/Heat	Burning sensation, painful, heat	23.1
				Tingly/Pungent	Tingly sensation, sourness (none-intense), pungent	23.1

[1)]A, Appearance; O, odor; F, Flavor; T, Texture/mouthfeel

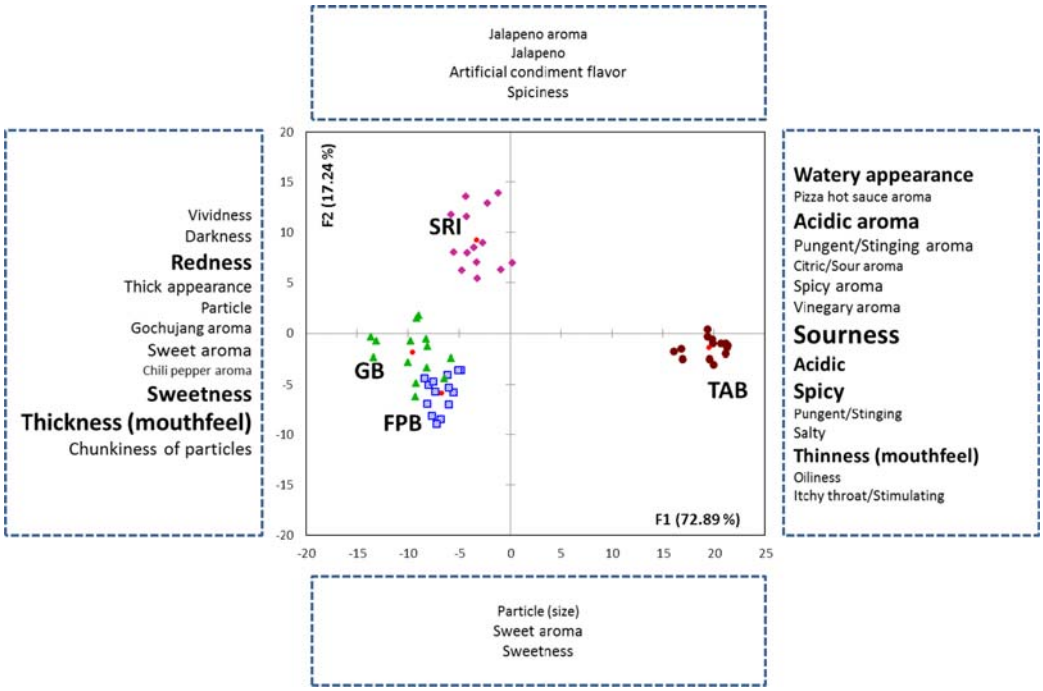

Fig. 2. Consensus space obtained using GPA from the evaluations of Korean consumers on 4 different hot sauce samples. The descriptors were selected terms that had correlation coefficient higher or equal to 0.70 and 0.60 with dimension 1 and 2 of the consensus configuration, and were elicited by at least 2 subjects. The font size of the descriptor indicates the frequency of elicitation.

panel, all groups used similar semantic terms to describe this product. The main characteristics that defined the first dimension of product differences for both Korean and US consumers were color, viscosity, sour-related terms (acidic, vinegary), sweet, and spiciness (Fig. 2 and 3). Also, the descriptive analysis results showed that TAB was mainly described with stronger "sour taste", "bitter taste", "vinegar", "chili pepper" flavors and "pungent", "burning" mouthfeel characteristics (Fig. 1).

Overall, for the primary dimension of product differences, Korean and US consumers shared similarities in differentiating TAB from the other samples and also in describing the TAB sample using similar terms, which was also comparable to the descriptive analysis results (Fig. 1). Blancher *et al.* (10) also found similar product configurations as well as key sensory concepts between French and Vietnamese consumers using sorting and flash profiling. It is known that consumer orientated methods such as Napping®, sorting, flash profiling, and free choice profiling used by untrained judges provide results comparable to traditional descriptive analysis for major differences (12,31). Hence, it was assumed that regardless of the panel's cultural background differences, there would be strong agreement between Korean and US consumers' product perceptions for the distinct primary differences, which included color, viscosity, sour-related terms (acidic, vinegary), sweet and spiciness. However, in contrast to the observations in this study, Kim *et al.* (11) found large differences in the perceptions of green tea products between French and Korean consumers even across the first dimension that explains the main sensory differences. The discrepancy in the findings by Kim *et al.* (11) and this study can be explained with two aspects. Firstly, in the study by Kim *et al.* (11), the primary dimension of product differences was mainly explained by flavor characteristics, whereas in this study, the main differences included appearance and texture/mouthfeel characteristics. Because flavor recognition largely depends on odor/flavor knowledge, which is generally dependent on cultural backgrounds (30), differences in the findings by Kim *et al.* (11) and in this study may have occurred as a result. Another reason could be the range of product differences. Because the products employed in the study were very different from each other, the primary product differences may have been too obvious for disagreements between the consumers from the two cultures.

Unlike the primary dimension of product differences, the way US and Korean consumers separated the products in the second dimension was different. While Korean consumers differentiated sample SRI from the two hot sauce samples using fermented ingredients, GB and FPB (Fig. 2), US consumers perceived more similarities between samples SRI and FPB and regarded sample GB as different from the other two (Fig. 3). On the other hand, the trained descriptive panel differentiated the three products, GB, FPB and SRI, to be all very different from one another (Fig. 1).

Koreans have a long tradition in their cuisine of consuming fermented products. Most well-known fermented products in Korean cuisine can be largely categorized into plant fermented products such as kimchi (32); soybean fermented products such as *gochujang*, *deonjang* or soy sauce (25,27); and fishery fermented products such as *shikhae* (32). Sample FPB is a product containing fermented chili

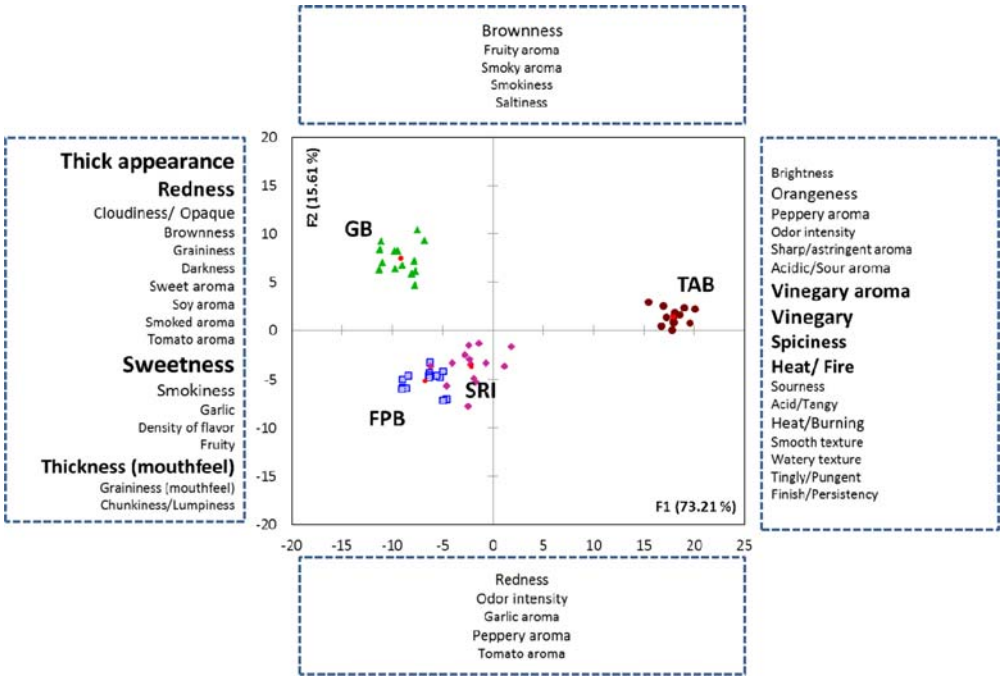

Fig. 3. Consensus space obtained using GPA from the evaluations of US consumers on 4 different hot sauce samples. The descriptors were selected terms that had correlation coefficient higher or equal to 0.70 and 0.60 with dimension1 and 2 of the consensus configuration, and were elicited by at least 2 subjects. The font size of the descriptor indicates the frequency of elicitation.

pepper, which is based on plant fermentation, whereas sample GB is a product containing *gochujang*, which is based on soybean fermentation. Although plant fermentation and soybean fermentation deliver different sensory characteristics, because of Korean consumers' long tradition of consuming fermented products, the Korean consumers may have captured the common feature found in 'fermented' products. This observation can be partially explained by the results of the study by Park *et al.* (33), who used sorted Napping® to investigate the sensory perceptions of the young and the old on Korean traditional fried rice cookies (*yackwa*). In this study, the authors found a difference in perception between consumers of the two age groups, with older consumers better recognizing the flavors of the more traditional products than the younger consumers. The authors in this study attributed this observation to the fact that because older consumers had more exposure to traditional *yackwa* products, the level of flavor familiarity for these products differed between the old and the young, resulting in better recognition of the traditional *yackwa* flavors by older consumers. Moreover, it was found that SRI, which is the sample that Koreans perceived differently from GB and FPB, was mainly described using the terms "jalapeno aroma", "jalapeno flavor", "artificial condiment flavor" and "spiciness", which were highly loaded on the positive PC 2 dimension (Fig. 2). Jalapeno is a typical spicy ingredient that is widely used in Mexican dishes (34) and ingredient that US consumers are generally more exposed to than Koreans. However, the US consumers did not use such descriptor for SRI, but rather it was used by Korean consumers for describing SRI. Based on this observation, it seems that Koreans used the term "jalapeno", not necessarily because they had actually tasted jalapeno, but the use of the term can be an indication that the sample was exotic compared to the other two samples.

US consumers perceived SRI, one of the top selling hot sauces in the US, and FPB to share more similarity than sample GB, along the second dimension (Fig. 3). The difference was mainly described by color and odor/flavor characteristics including "fruity aroma", "smoky aroma", "smokiness", "saltiness", "odor intensity", "garlic aroma", "peppery aroma", and "tomato aroma" (Fig. 3). Although GB and FPB both contain fermented flavors that maybe perceived as ethnic by US consumers, US consumers seemed to perceived sample GB, a product containing *gochujang* (soybean fermentation), to be more different from SRI than FPB, a product containing fermented chili pepper (plant fermentation). Fermented foods that are well developed in the Western culture include bread, cheese, sausage, sauerkraut, yogurt, olives, pickles, etc., which are mostly based on dairy, plant, cereal or meat fermentations. Therefore, it appears that for US consumers, flavors derived from soybean fermentation are less familiar, since they do not have much experience tasting such flavors. In addition, several cross-cultural studies support this implication by showing the low familiarity of US consumers with products that use *gochujang* as an ingredient. In the study by Chung *et al.* (1), investigating the effects of sensory and non-sensory factors on the liking of Korean style salad dressing and beverages among US subjects, it was reported that "hot pepper and vinegar" salad dressing, which was made of hot red pepper paste (i.e. *gochujang*), vinegar, sugar, minced green onion and minced garlic, had the lowest familiarity rating

among US consumers compared to "mustard", "soy sauce and vinegar", and "sesame" dressings. In addition, in the study by Choi *et al.* (3), the chicken marinade sauce containing hot pepper paste (i.e. *gochujang*) showed lower familiarity ratings than "tomato based barbeque sauce", "traditional barbeque sauce", "traditional barbeque sauce with spicy note", and "teriyaki sauce" among US consumers. Hence, the specific flavor characteristics of *gochujang* such as "soy sauce", "*meju*", "fermentation" (28), which are related to soybean fermentation, induced the US consumers to perceive the sample as different from others. As Chrea *et al.* (35) found in their work, odor knowledge, which is culture dependent, influences how consumers categorize odor, which eventually can affect the perception of sample differences.

To sum, the present work investigated how the perceptions of Korean and US consumers differed when their level of familiarity varied within the product category. For the distinct primary sample differences, Korean and US consumers were in good agreement despite their different cultural backgrounds. On the other hand, for product differences that less stood out, it was found that consumers of two cultures perceived the products differently, and this discrepancy was seemed to be mainly affected by flavor familiarity differences.

Although this study has limitations by investigating small number of consumers, thus it is hard to be generalized; this study has shown consumers' experience with flavors according to their cultural background playing a role in product perceptions. Therefore, this research emphasizes the importance of investigating the perceptual differences of consumers when promoting a new ethnic flavor from a different culture within existing flavors in the market that are familiar to the target consumers. Further investigations with larger number of subjects and with more number of samples will be necessary to fully understand the role of flavor familiarity on product perceptions.

Acknowledgment This research was supported by the High Value-added Food Technology Development Program, Korean Ministry of Agriculture, Food and Rural Affairs (311034033HD120). The study was also supported by RP-Grant 2015 of Ewha Womans University (Seoul, Korea).

Disclosure The authors declare no conflict of interest.

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