Comparison of consumer perception and liking of *bulgogi* marinade sauces between Korea and Japan using flash profiling

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Abstract This study compared the perception of and preference for seven *bulgogi* marinade sauces between Korean and Japanese consumers. Flash profiling (10 panelists each) and consumer test (97 Japanese and 102 Koreans) were conducted. Results showed that both Korean and Japanese panelists perceived the samples similarly but described using different terms. There were significant cross-cultural differences in most liking and just-about-right attributes, except texture liking and sweetness. Both consumer panelists preferred sweeter samples, but Japanese consumers rated liking for less sweet samples higher than Korean consumers. Japanese consumers considered strong saltiness, umami, and soy sauce flavor as “just-about-right,” whereas Korean consumers considered the same levels as “much too strong”. Familiarity showed a significantly positive correlation with both Korean and Japanese consumers’ liking, but authenticity was only significantly correlated with Korean consumers’ liking. This indicates that perception of authenticity might not have a strong impact on Japanese consumers’ liking.

Keywords: cross-cultural comparison, *bulgogi* marinade sauce, flash profiling, consumer liking

Introduction

Consumers’ growing interests in ethnic foods have encouraged the industry to seek for business chances in ethnic food sectors (1). In Korea, *bulgogi* has been most frequently selected as a product with a great potential for success in the global market, since it is one of the most well-known and favored Korean foods (2,3). Several studies have been conducted to identify its drivers of liking in foreign markets (4–6), but these studies primarily focused on the US and China, not Japan, where Korean foods have a market share of 30% in the ethnic food market (7). The Japanese consumers’ general perception of *bulgogi* has been assessed in surveys (2,8), but no extensive sensory study on *bulgogi* has been conducted. Therefore, it is necessary to understand Japanese consumers’ perception of and liking for *bulgogi* to explore the direction of product development in the Japanese market. This study specifically focused on a ready-to-use marinade sauce. Considering that there is a growing interest in ethnic condiments and sauces worldwide (9), the marinade sauce, which is more readily accessible to consumers through retail markets than *bulgogi* dish served in restaurants, can reach a broader population in the target market.

Previous studies have suggested that familiarity to foods, which can be developed by repeated exposures or incorporating familiar

flavor components, can moderate consumers’ hedonic and sensory responses to ethnic foods (1,4,10,11). Thus, familiar foods would face less resistance from foreign consumers (1,11). However, at the same time, consumers expect exotic sensory experiences that represent unique feature of a foreign culture, which can be referred to as authenticity, from ethnic foods (12). Authenticity is perceived either in objective ways (e.g. experts’ evaluation), or in subjective ways (e.g. consumer perception based on the image that they have about the culture) (12). Thus, it is important to understand the potential effect of not only familiarity of a product but also target consumers’ perception of authenticity on liking for an ethnic food.

Conventionally, the sensory description of products is obtained using quantitative descriptive analysis (QDA). However, QDA is usually time-consuming and expensive due to extensive panel training process. Several consumer-based profiling techniques have been developed as cost- and time-effective alternatives to QDA (13). One such technique, flash profiling (FP), allows rapid description of products by combining the principles of free choice profiling and ranking (14,15). FP has been successfully applied to various products and was proven to produce a comparable result to that of conventional profiling (13). FP is known to accurately capture consumer perception by providing a rich array of descriptors of products making it a useful tool for a cross-cultural study (13).

This study was conducted to understand cross-cultural differences in sensory perception of and hedonic responses to *bulgogi* between Korean and Japanese consumers using FP and consumer test. In addition, non-sensory perceptions such as perceived familiarity and authenticity were measured to investigate the effect of these factors on the overall liking for the product.

Materials and Methods

Sample preparation Considering the market share ranking in each country, four Korean and three Japanese *bulgogi* marinade sauces were purchased (Table 1). The samples were stored at $1\pm0.2^{\circ}\text{C}$ until use. Beef round tip was purchased from a local supermarket 1 day before sensory evaluation. The beef was sliced into $3\times4\times0.2\text{ cm}^3$ and divided into portions for each test session. Each portion was refrigerated ($1\pm0.2^{\circ}\text{C}$) in a sealed polypropylene bag until usage. A portion of the beef was marinated with a sauce at a ratio of 5:1 for 30 min. The marinated beef was stir-fried for 3 min in a preheated pan (diameter 28 cm) on a high heat of a portable gas stove (Supercrown 1, Suntouch Co., Keum-san, Chungcheongnam-do, Korea). The cooked samples were immediately transferred to a 700ml- thermos to maintain the temperature at $62\pm4^{\circ}\text{C}$.

Flash profiling

Panel: Korean panelists (five males and five females, aged 20–29 years old) were recruited from Kookmin University (Seoul, Korea). Japanese panelists (one male and nine females, aged 20–39 years old) were recruited from a private Korean language institute (Seoul, Korea). The recruitment criteria for the Japanese panel were those who were born and raised in Japan, and those who had consumed *bulgogi* before.

Sample presentation: *Bulgogi* samples were prepared as mentioned above. Then, 40 g of each sample was presented in an individual water bath (80°C) to maintain the sample at 63°C throughout the test. Bottled water ($22\pm2^{\circ}\text{C}$) and cooked white rice (Haet-bahn, CJ Cheiljedang Corp., Seoul, Korea) were provided to cleanse the palate. The samples were coded with three-digit random numbers and were presented to the panelists side-by-side following Williams Latin Square design to prevent first-sample and order biases (16).

Test procedure: For the Korean panel, FP was conducted for five sessions, 1 h per session, following the procedure suggested by Delarue and Shifferman (15), with some modifications as follows: Because the panelists were not trained, more sessions were given to facilitate panelists' descriptor developments. In the first session, the panelists were introduced to the FP procedure. In the next two sessions, the panelists were exposed to *bulgogi* samples and developed their own descriptors individually. Selected descriptors were shared and each panelist modified their lists by adding terms from the lists of shared terms or replacing their own terms with that from the list. After the panelists finalized their own list of descriptors, they

practiced evaluating using ordinal scales. The main session was repeated twice. The panelists evaluated the samples in an attribute-by-attribute manner. The panelists were asked to rinse their mouth using water and cooked rice between testing the samples.

FP for the Japanese panel was performed the same manner as for the Korean panel. However, considering that the Japanese were less familiar with *bulgogi*, sessions for descriptor development and ranking practices were extended to 5 sessions. FP for each panel was conducted in each country's language.

Statistical analysis: Each panelist's ranking was converted into scores from 1 to 7 (1=weakest, 7=strongest) (15). If two or more samples were in the same rank, the average rank of identical samples was assigned to each. A multi-block data matrix was generated by compiling several sample (row)-by-attribute (column) sub-data matrices each representing individual panelists' result. The data from two replications were compiled as separate sub-matrices in the multi-block data table. Multiple factor analysis (MFA; 13) was applied to identify consensual space from individual configurations (FactorMineR package (17)). The RV coefficients (RV) were calculated to measure the similarity between the Korean and the Japanese FP results, as well as between the first and the second replicates for each panelist to check reproducibility.

Consumer liking test

Consumer panel: A population of 100 healthy adults was recruited from the consumer pool of DACAD Japan Ltd. (Osaka, Japan). Recruitment criteria were identical to those for FP. A total of 102 Korean participants were recruited from on-campus and surrounding local communities of Kookmin University. Both Korean and Japanese consumers were matched for gender and age.

Sample preparation: Samples were prepared in the same manner as for the FP. Immediately after cooking, each sample was maintained in a thermos at $62\pm4^{\circ}\text{C}$. When requested by the panelists, 30 g of each sample was immediately served on a disposable white polypropylene plate labeled with a three-digit random code. Bottled water and cooked rice were provided to cleanse the palate.

Evaluation procedure: The panelists were asked to rate the overall liking and the liking for appearance, flavor, and texture using 15-point hedonic scales (1=dislike strongly, 15=like strongly). Saltiness, sweetness, umami, and soy sauce flavor were evaluated using 9-point just-about-right (JAR) scales (1=not strong enough, 5=just about right, 9=too much strong). Additionally, familiarity and authenticity (7-point Likert scale) were rated. Authenticity in this study was defined as consumer perception of typical sensory characteristics of a food cooked in the traditional Korean way. Finally, demographic information and consumption behaviors were collected.

The samples were tasted in a monadic way, following Williams Latin Square design. The panelists were instructed to rinse their mouth using bottled water and cooked rice between testing the samples, while taking a break for 1 min between the samples. Korean consumer test was performed in an individual booth at

Table 1. Information of seven *bulgogi* marinade sauces used in this study

Sample	Ingredients			Manufacturer
	Marinade base	Culinary vegetables	Others	
BS	Soy sauce mixed with vinegar, sugar	Garlic, onion, ginger	Apple, soybean paste, sesame oil	Japan
BMS	Soy sauce mixed with vinegar, sugar	Garlic, onion, ginger	Apple, soybean paste, sesame oil	
BM	Soy sauce, fructose, sugar	Garlic, onion, ginger, red pepper, chili	Apple, pear, lemon juice, sesame oil, artificial flavor enhancer	
BC	High fructose corn syrup (HFCS), sugar, soy sauce	Garlic, onion, ginger	Pear, flavor enhancer	Korea
BB	Soy sauce, sugar, HFCS	Garlic, onion, green onion	Apple, pear, black pepper, flavor enhancer	
BOO	Soy sauce, sugar, corn syrup	Garlic, onion, ginger	Glycine, alanine, xylose	
BOB	Soy sauce, HFCS	Garlic, onion, ginger,	Apple, pear, black pepper, citric acid, artificial smoke flavor	

Kookmin University. Japanese consumer test was conducted in the seminar room of Umeda Act III art center (Osaka, Japan).

Statistical analysis: Responses from three Japanese consumers were excluded from the data because they did not complete more than half of the questionnaire. Thus, a total of 97 Japanese responses and 102 Korean responses were used for data analysis. A nested analysis of variance (ANOVA) was conducted to test the significance of the effects of nationality, sample, and their interactions on consumer responses. The panel (random) was nested within nationality. Mixed ANOVA was performed to test the significance of differences in hedonic and sensory attributes among the samples within a country. The ANOVA model included sample (fixed) and panel (random) as the main factors. Duncan's multiple range test and independent t-test were followed as post hoc tests. One-sample t-test was conducted to identify if JAR ratings are significantly different from JAR middle point (18). The relationships between overall liking, familiarity, and authenticity were identified using Pearson correlation analysis.

To visualize the drivers of liking in each country, external preference map was constructed by regressing MFA coordinates of the FP on the principal components of hedonic data using PREFMAP function of XLSTAT-MS (ver. 2013.3, Addinsoft, Paris, France). Other statistical analyses were conducted using SPSS package (ver. 23, IBM, Armonk, NY, USA). The significance was tested at $p < 0.05$.

Results and Discussion

Flash profiling The Japanese panel generated 35 attributes and the Korean panel used 62 attributes. Among them, sensory variables that were well-represented on each dimension were selected to facilitate interpretation (Fig. 1) based on the contribution and squared cosine values ($\cos^2$) of attribute vectors. Considering the large interpersonal variability in FP descriptors, the cut-off values for

contribution and $\cos^2$ were set at 0.6 and 0.5 for each dimension, respectively. Selected terms were marked on the product configurations to help interpretation of the results.

Korean flash profile: Dimensions (Dim) 1 and 2 explained 51.99% of the total variance (Fig. 1A). Dim 1 contrasted BM, BMS and BS, which were explained by *salty*, *doenjang*, *cheese*, and *red pepper* that were loaded in the positive direction of Dim 1, to the other samples. BOO, BC, BOB and BB were described by *sweet*, *barbeque*, and *beef-jerky*. The sensory characteristics of BM and BOB were primarily explained by Dim 2. BM was characterized by *garlic* and *sesame oil*, and BOB was distinguished from other samples for its *sourness*.

BC, BOB and BM were better characterized on Dim 3 (Fig. 1C and 1E). BC was differentiated from BM by *greasy* and *nutty*, whereas BM and BOB were not highly correlated with these attributes. On Dim 4, BMS and BOO were associated with *green onion* and *iron*, and BS had *black pepper* and *grilled garlic* flavors. Dim 5 showed that BB was differentiated from BOO by the presence of *beef fat* and *MSG taste*. **Japanese flash profile:** Figure 1B shows that Dim 1 and 2 explained 57.88% of the total variance. Overall, the samples were positioned similar to the Korean result on Dim 1, exhibiting the contrast between BB, BOB, BC and BOO described with terms *teriyaki sauce*, *mirin*, *sweet*, *sweetness of beef*, and *umami* and BS, BM and BMS described as having *spiciness*, *saltiness*, taste of *NaCl*, and flavors of *Chinese sauce* and *soy sauce*.

The sensory variance between BC and BM was the second largest, explained on Dim 2. BC was characterized by *unpleasant beef flavor*, whereas BM was perceived as being *tender*. BOB was positioned in the negative direction of Dim 3, which was characterized by *smoky* and *sour*. BC and BM were characterized by *unique flavor*, whereas BOO was considered less *unique* on Dim 3 and 4 (Fig. 1D). Dim 5 indicated that BOO was associated with *bulgogi sauce* in its positive direction, whereas BB and BMS had a weak *bulgogi* characteristic (Fig. 1F).

Fig. 1. Product configuration on Dim 1–5 from the flash profiling by the Korean panelists (A, C, and E) and the Japanese panelists (B, D, and F).

Comparison of flash profile between Korea and Japan: The RV between the two countries was 0.96, indicating a good agreement in product perception, but minor differences were observed in Dim 2–5 (Fig. 1). Across cultures, a large sensory variance in taste, appearance, and texture among the samples was perceived and processed similarly (1,11,19), but the perception of odors/flavors showed more differences (20,21). Because olfactory stimuli are recognized by matching the perception to a pattern that is stored in the memory (22), a subject's cultural background can modulate odor/flavor perception by controlling the construction of a pattern. In this study, differences among the samples on Dim 2–5 primarily resulted from variances in flavor perceptions, which seemed to be associated with their previous experiences with *bulgogi*. For example, the Korean panelists, who are familiar with *bulgogi*, distinguished the samples based on flavors of the sauce ingredients such as green onion, garlic, and black pepper, whereas the Japanese panelists' criteria were built using less specific terms such as *unique* or *teriyaki* sauce-like flavors.

It is noteworthy that even the samples distinguished on the same perceptual basis were described using very culture-specific descriptors, e.g., BM and BMS described as *doenjang* by the Koreans and taste of NaCl (しおからい) by the Japanese. This indicates that the effect of culture was more apparently found in verbal description than in sample configurations.

Further, previous experiences with *bulgogi* also seemed to influence panel performances. The Korean panelists used more diverse descriptors (6–23 terms/person) than the Japanese panelists (5–13 terms/person). Also the RVs calculated between two replications imply that the Japanese panel showed a lower reproducibility than the Korean panel. Compared to Korean panelists' RVs ranged from 0.65 to 0.86, those of eight Japanese panelists were 0.53–0.87, but two panelists recorded an RV of less than 0.5. This result may be attributed to the positive effect of previous experiences on olfactory identification and subjective feeling of intensity, which had been reported by Distel and Hudson (23).

Fig. 2. Mean ratings of (A) liking, (B) just-about-right (JAR) intensities, and (C) familiarity and authenticity of seven *bulgogi* marinade sauces. Different alphabet letters and asterisk indicate significant differences among the samples within a country and between countries, respectively (Duncan's multiple range test and independent t-test, $p < 0.05$). Bold letters (B) indicate significant difference from the JAR value (5 on the 9-point JAR scale; one-sample t-test, $p < 0.05$).

Consumer liking test

Consumer profile: The Korean consumer panel consisted of 50% males and 50% females. Consumers in the age groups of 20, 30, and 40 years old accounted for 52.9, 32.3, and 14.7% of the total participants, respectively. Most consumers were students (48.0%) or full-time workers (40.2%), and 11.2% of participants were not employed. Majority of the participants consumed *bulgogi* at home (60.8%) and more than once per month (69.6%). When they prepare *bulgogi* at home, the participants use home-made marinade sauce most commonly (56.9%), but 23.5% of participants use commercial marinade sauce.

The Japanese panelists were also matched in gender (48.5% males and 51.5% females). Regarding their age, 42% of the participants were in the age group of 20s, 30.9% were in the 30s age group, and 28.9% were in the 40s age group. Full-time workers accounted for 45.4%, unemployed accounted for 30.9%, and students and part-

time workers accounted for 23.7% of the total participants. Majority of Japanese consumers (74.2%) consumed *bulgogi* less frequently than once per month. Only one-third of participants had previously tasted authentic Korean *bulgogi*. Instead, 53.6% of the participants consumed *yakiniku*, a Japanese style-grilled beef that is comparable to *bulgogi*, once per week. Participants mostly consumed *bulgogi* in a Korean restaurant (55.7%) or grilled marinated *bulgogi* sold in a supermarket at home (23.7%).

Consumer liking: Both Korean and Japanese panelists significantly preferred BB, BOO, and BOB to BS, BMS, BM, and BC. BB was the most liked whereas BMS was the least liked (Fig. 2). Likings for appearance, flavor, and texture showed similar tendency as that of overall liking. Significant interactions between sample and nationality were observed in ratings of overall liking ($F_{5,1180}=4.58$, $p < 0.001$) and flavor liking ($F_{5,1180}=2.97$, $p < 0.01$). The Japanese panelists rated overall liking of BS, BMS, BM, and BC significantly higher compared

Fig. 3. External preference map (small dots-individual consumer liking; large dots-see Table 1 for sample abbreviation) by (A) the Korean panelists and (B) the Japanese panelists.

to those of the Korean panelists (Fig. 2). Particularly, they liked BM as much as BB, BOO, and BOB. For flavor liking, such a tendency was less apparent, showing significant differences only for BMS and BB.

There was a significant effect of nationality on liking ratings of overall ($F_{1,1180}=29.75$, $p<0.001$), appearance ($F_{1,1180}=13.64$, $p<0.001$), and flavor ($F_{1,1180}=6.69$, $p<0.01$). In general, Japanese consumers tended to give higher scores to overall liking and flavor liking but gave lower scores to appearance liking than Korean consumers did (Fig. 2).

The drivers of liking are illustrated in Fig. 3. *Sweetness* and flavors of *barbecue*, and *beef jerky* (Korean panelists) and *umami*, and flavors of *teriyaki sauce* and *good beef* (Japanese panelists) were the major drivers of liking. The sensory attributes expressed as *saltiness* and *doenjang* by the Koreans drove their disliking, but the same attributes expressed as *saltiness* and flavors of *Chinese sauce* and *soy sauce* by the Japanese had less negative impact on their liking. To

some consumers, flavors of *Chinese sauce* and *soy sauce* even seemed to have a positive effect on liking.

JAR ratings: In general, both panel evaluated that BS, BMS, and BM were significantly saltier than the other samples, and that BM had significantly stronger soy sauce flavor than BC, BB, BOO, and BOB (Fig. 2). However, the significant effects of nationality on saltiness ($F_{1,1180}=196.61$, $p<0.001$) and soy sauce flavor ($F_{1,1180}=98.25$, $p<0.001$) were observed. While the Korean panel perceived samples as having either much too strong or just-about-right saltiness and soy sauce flavor, the Japanese panelists rated these characteristics significantly lower than those by Koreans, perceiving saltiness and soy sauce flavor of the samples as being either at JAR level or not strong enough.

Figure 2 shows that both panel rated that sweetness of BS, BMS, and BM was not strong enough and BC, BB, BOO, and BOB had either

just-about-right or much too strong level of sweetness. However, significant effect of nationality x sample on sweetness was observed when ratings were pooled across the samples ($F_{5,1180}=2.13, p<0.05$). Compared with the Korean panelists' ratings, the Japanese panelists tended to give slightly lower sweetness ratings, but they rated sweetness of BB, BOO, and BOB slightly higher.

There were significant effects of nationality ($F_{1,1180}=118.28, p<0.001$), and nationality x sample on umami ($F_{5,1180}=4.39, p<0.001$). The Japanese panelists rated umami significantly lower than by the Koreans, judging them as being either not strong enough or just-about-right. Also, while the Koreans evaluated that umami of BC was significantly stronger than the other samples, the Japanese panelists thought that BB, BOO, BOB, and BM had significantly stronger umami than that of BS and BMS, indicating that the Japanese umami ratings were more discriminative than by the Koreans.

Familiarity and authenticity: The Korean panelists perceived that BB and BOO were significantly more familiar and authentic than the other samples (Fig. 2). BOB was perceived as being significantly more familiar than the other samples, but not as being significantly more authentic. When cross-checked with the FP result (Fig. 1), the Korean panelists perceived the samples with strong sweetness as being more familiar and authentic. Familiarity ($r=0.78, p<0.01$) and authenticity ($r=0.68, p<0.01$) also significantly correlated with overall liking.

Interestingly, the Japanese panelists also thought that BB, BOO, and BOB, the Korean products, were more familiar than the other samples. It seems that their sensory characteristic described as *teriyaki* flavor in FP (Fig. 1B) evoked perception of familiarity. However, the significance of between-sample differences indicates that the familiarity ratings were less discriminative than those by the Koreans. Meanwhile, the Japanese panelists judged the authenticity of the samples differently from that by the Koreans. The authenticity of the samples was not significantly different from each other in general, but only BM was considered as being significantly closer to authentic *bulgogi* than BOB. This may be because the Japanese consumers might base their sensory criteria for authenticity on BM, which is currently sold in the Japanese market as Korean-style *bulgogi* marinade sauce.

It is noteworthy that BS, BMS, and BM, the samples produced in Japan, were perceived as being more familiar and authentic by the Japanese panelists than by the Korean panelists (Fig. 2). In contrast, BB, BOO, and BOB, which were manufactured in Korea, received higher ratings from the Korean panelists than from the Japanese panelists. Similar to the Korean result, the overall liking significantly and positively correlated with familiarity ($r=0.74, p<0.01$) but less correlated with authenticity ($r=0.46, p<0.01$).

Altogether, the results of the consumer test support the critical role of familiarity perception in hedonic responses that had been reported in previous studies (1,5,21). Familiarity, which is highly correlated with exposure level (10,11), can increase the liking for an ethnic food by improving the perceptual fluency, the ease of

processing stimuli (23). It is also interesting to note that the Japanese considered the stronger umami and soy sauce flavor as optimal levels than those considered by the Koreans. This seems to be attributed to the effect of Japanese food culture that is often characterized by the use of umami-containing ingredients (bonito and konbu) and soy sauce (24).

Authenticity influenced the Koreans' liking more than the Japanese liking. The Japanese perception of authenticity did not correlate with the overall liking as much as the Koreans'. In addition, their rating of authenticity indicates that their criteria for judging authenticity had not been well-structured. In contrast, the Koreans who had been more exposed to traditional *bulgogi* had developed a more substantial idea on flavor authenticity. However, the Korean consumers' authenticity scores were lower than 4 on the 7-point scale in general, indicating that they did not agree with or were neutral to the notion that samples were authentic. It may be because their idea and expectation of authenticity seem to be built based on *bulgogi* daily consumed (10), which is mostly home-made and not the commercial products. Results of Japanese consumer test suggest that Japanese consumers may not much stress authenticity when they made a judgment as to liking. It was suggested that the Koreans rate Korean foods in the frame of "tradition" or "authentic," whereas foreigners are under the frame of "ethnic" or "exotic." (25)

The present study provides the insight on Japanese consumers' sensory perception of and hedonic responses to *bulgogi* marinade sauce, in comparison with those of the Korean consumers'. Outcomes of this study support the positive association between previous consumption experiences, which is formed depending on one's cultural background, and sensory and hedonic perceptions as well as perceived authenticity and familiarity. However, more specific nature of this relationship is yet to be understood. This calls for future research attention to investigate multivariate relationships between behavioral measures of food culture, such as a degree of exposure to and knowledge of *bulgogi*, and sensory and cognitive responses.

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