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Ingredient and Salinity Variations in *Doenjang* Stews Sold in a College Town and Consumer Acceptance of *Doenjang* Stews among Korean College Students

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ABSTRACT: This study determined the ingredient and salinity variations in *Doenjang* stew sold near a college campus and determined its consumer acceptance with varying salinity levels. *Doenjang* stews from four restaurants near a college campus were collected around lunchtime for 3 days. The salinity and weight of each ingredient included in *Doenjang* stews were recorded. Consumer acceptance testing on the stews was also conducted (n=98). Overall, variations in *Doenjang* stew recipes, including salinity values and the weight of each ingredient, between and within restaurants were also observed ($P<0.05$). The salinity of *Doenjang* stews collected from different restaurants ranged between 1.2% and 1.7%, higher than that recommended by the Korean government. *Doenjang* stew with a salinity of greater than 1.3% was most liked by consumers, whereas a salinity of 1.2% was least liked. At the same salinity value, a high stock amount of *Doenjang* stew was preferred to a greater extent than that with a high number of ingredients in *Doenjang* stew, suggesting that various ingredients included in the recipe do not necessarily increase consumer acceptance of stew.

Keywords: consumer acceptance test, *Doenjang*, *Doenjang* stew, ingredient variation, salinity

INTRODUCTION

Doenjang is one of the three most accepted soybean fermented food ingredients in Korea as part of the Korean cuisine, in addition to soy sauce and red pepper paste (Sun and Baek, 2008). It is typically sold as a paste and applied to a soup or stew as part of the recipe. The typical consumption scenario of *Doenjang* is either soup or stew in Korean cuisine (Paek et al., 2016; Chon and Kim, 2020). One difference between soup and stew is how it is served in a meal: soups in Korean cuisine can be served as one of the main dishes, whereas the stew is typically served as a side dish. Another difference is the concentration of *Doenjang* paste in water: soup requires a small amount of *Doenjang* paste, implying a watery mouthfeel, whereas stew exhibits a thicker texture. Although a standard recipe for *Doenjang* stew is available, it is not followed by cooks in each household and restaurant, meaning that recipes' variations are widely applied based on different ingredients and types of stocks used for making stews. The standard *Doenjang* stew recipe includes *Doenjang* paste, green and red peppers, onions, dried mushroom, and red pepper seasoning (Kye et al., 1995). Different ingredients have been used in different studies: for example, Kim and Han (2008) used beef, mushrooms, green onions, ginger, and red peppers in boiling water; Joo and Shin (2005) used dried anchovies, garlic, red pepper powder, and green onions; Jeon et al. (2020) used beef stock, green onion powder, and garlic powder. Ingredient variations were reported in peer-reviewed journal papers, and considerable variations were observed in commercial restaurant recipes. According to different studies, variations are not limited to ingredients included in the recipes but the concentration of *Doenjang* pastes included in the *Doenjang* stew.

Sodium consumption among the Korean population is relatively high because its cuisine heavily depends on fermented foods, exhibiting a high salt content. As reported in the nutritional components data by Korean restaurants, the sodium content of *Doenjang* stew is ~2,021 mg based on one serving size (400 g), corresponding to 1.26% salinity (Korea Food and Drug Administration, 2012). The Korean government recommends a salinity of less than 0.8% for soups and stews. However, Kim et al. (2009) reported that typically consumed soups and stews in restaurants exhibit considerably high salinity levels. A previ-

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ous study reports that *Doenjang* soups collected from commercial restaurants indicate a salinity of ~0.9% higher than the government recommendation of 0.8% (Lee and Song, 2009). Additionally, previous studies found that the saltiness of stew soup was high in the order of restaurants, home meals, and school meals (Park et al., 2020). In a similar study, the sodium content of *Doenjang* stew was higher in restaurants than in-home meals and food services (Jiang and Lee, 2017). Another study on *Doenjang* stew reported that consumers preferred *Doenjang* stew with a salinity of 1.4%, whereas the government recommended a salinity value of about 1.26% for *Doenjang* stew (Chon and Kim, 2020). Therefore, this indicates a gap between consumer preference and government recommendation. Chon and Kim (2020) showed that the salinity of *Doenjang* stew may vary as the concentration of *Doenjang* varies. There is a growing trend of research on low-salt *Doenjang* to lower the salinity of foods using *Doenjang*, such as *Doenjang* stew (Kang et al., 2016; Boo et al., 2017; Kim et al., 2017; Choi et al., 2018).

Variations in food ingredients within a restaurant are challenges of soup and stew foods, which is a limitation for developing strategies to reduce sodium in these food categories. To our knowledge, ingredient variations in soup- and stew-type foods have not been intensively investigated. Therefore, the objective of this study is twofold: 1) to determine the ingredient and salinity variations in *Doenjang* stew sold near a college campus; and 2) to determine consumer acceptance of *Doenjang* with varying salinity levels among college students.

MATERIALS AND METHODS

Collection of *Doenjang* stew from restaurants near a college

Doenjang stew was purchased from four restaurants near the Jeonbuk National University-Jeonju campus. The restaurants were selected based on convenience, frequency of student visits, and restaurant location, with purchases made during lunchtime within a 1-h period. Upon collection, *Doenjang* stew was sifted, and the ingredients of *Doenjang* stew from different restaurants were collected. Additionally, *Doenjang* stews were collected on three different days from the restaurants to determine daily variations within a restaurant.

Ingredient variation and salinity of *Doenjang* stews

After collection, the recipe variation was monitored by weighing each ingredient in the stew and standardizing by the weight of the ingredient divided by one serving size. Ingredient weight was reported as gram per 100 mL of the stew. The total weight of one serving size, ingredients (g), and stock (mL) per serving size were measured accordingly. The stock-to-ingredient ratio was then calculated by the volume of stock (mL) divided by the total weight of the ingredient (g). In addition to the ingredient characteristics, the salinity (%) of *Doenjang* stew was analyzed according to Mohr's method. Briefly, *Doenjang* stew was sifted through a sieve, followed by filter paper filtration (F1093-150, CHM GROUP, Barcelona, Spain). Salinity was then measured by titrating with 0.1 N $AgNO_3$, and 1 mL of 2% K_2CrO_4 was used as a titrate indicator. The salinity of *Doenjang* stew was measured in triplicates for all 3 days.

Consumer acceptance testing

Consumer acceptance testing was conducted following the standard practice for such testing. Twenty servings of *Doenjang* stew were purchased from each restaurant 1 h before testing; therefore, a fresh batch of *Doenjang* stew from each restaurant was served to consumers. Then, all 20 servings were poured into a pot and mixed thoroughly to minimize the ingredient variation within the restaurant. Once mixed, *Doenjang* stew samples were kept at 60°C in a closed lid until consumer testing was performed. Then, 40 mL of *Doenjang* stew samples were served to participants in a 75-mL white plastic disposable cup labeled with a random three-digit code. All samples were served with white rice. The stew ingredients were evenly distributed in each cup. Samples were monadically presented to the participants, and the order of presentation was randomized and balanced using a Latin-square design.

Participants for consumer acceptance testing were mainly students from the Jeonbuk National University-Jeonju campus, which were recruited by placing flyers, social network service posting, and text messages to the consumer database. Before testing, participants were asked to answer demographic-related questionnaires and evaluate appearance characteristics. Next, participants were asked to taste *Doenjang* stew and evaluate their likes and dislikes of the samples, including overall liking and liking attributes, including flavor, mouthfeel, salty taste, sweet taste, and umami taste liking, on a 9-point hedonic scale (1=extremely dislike, 5=being neither like or dislike, and 9=extremely like). Open-ended questions were included to capture the consumers' raw language on their likes. A paper ballot was used to collect data. After completing the consumer test survey, participants were compensated with a snack. The study protocol was approved by the Institutional Review Board of the Jeonbuk National University (approval no. JBNU 2020-08-007). The written informed consents were obtained from all participants.

Statistical analysis

Data analysis was conducted using XLSTAT (v.2020, Addinsoft, Paris, France). One-way analysis of variance was

done using Duncan's multiple range test to determine the differences between samples at the α=0.05 level.

RESULTS AND DISCUSSION

Salinity of *Doenjang* stews collected from different restaurants

Table 1 lists the salinity of *Doenjang* stews collected from different restaurants on three different days. The saltiness of the stew samples ranged from 1.2% to 1.7%, with values of 1.2% for DS1, 1.7% for DS2, 1.3% for DS3, and 1.3% for DS4 (DS means *Doenjang* stew). The salinity values for *Doenjang* stew range from 0.74% to 1.3% within the previously reported ranges (Song and Lee, 2008; Lee and Song, 2009; Kim et al., 2012). The values for *Doenjang* stews collected from the four restaurants were slightly greater than that recommended by the Korea Food and Drug Administration (0.8% salinity for stews). The saltiness of DS2 was greater than those of the other samples, and the salinity of DS1 was the lowest (P<0.05). Presumably, this could be related to the different addition amounts of *Doenjang* paste in the stews during preparation in each restaurant.

Daily salinity variations in *Doenjang* stews collected on different days were also monitored (Fig. 1), with significant differences in the salinity of the stew within a restaurant observed in DS1, DS2, and DS4 (P<0.05). Ranges of salinity values obtained for each restaurant were as follows: 1.0~1.3% in DS1; 1.6~1.9% in DS2; 1.1~1.4% in DS3; 1.2~1.4% in DS4. As shown in Table 1, the average salinity value of DS2 was at its highest, whereas the daily variation in salinity value was highest in the DS1 and DS2 samples. This result revealed a significant variation in the salinity of *Doenjang* stew within restaurants. This variation may be attributed to the: 1) different concentrations of *Doenjang* paste addition to *Doenjang* stew and 2) different *Doenjang* pastes added in the stew, as different salinity values were reported in *Doenjang* paste according to the manufacturing method (Kim and Lee, 2014). Regardless, the salinity of *Doenjang* stew collected from each restaurant varies on different days and between restaurants.

Table 1. Salinity of *Doenjang* stews (DSs) collected from different restaurants

	DS1	DS2	DS3	DS4
Salinity (%)	1.2±0.2^{b}	1.7±0.2^{a}	1.3±0.1^{b}	1.3±0.1^{b}

Data are presented as mean±SD of triplicate analyses. Numbers in a row with different letters (a,b) represent significant differences (P<0.05).

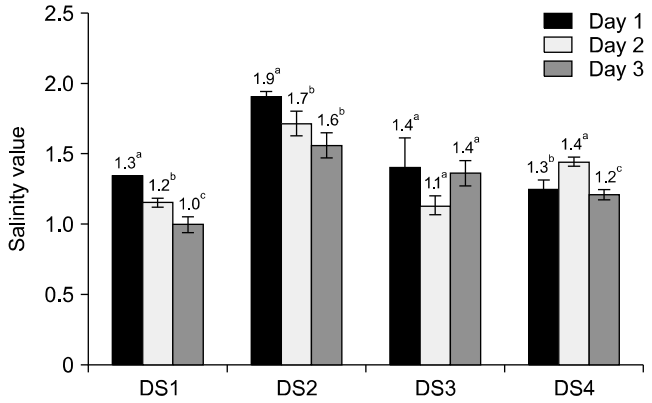

Fig. 1. Day-to-day salinity variation in *Doenjang* stews (DSs) collected from the different restaurants. Numbers with different letters (a-c) within samples represent significant differences (P<0.05).

Ingredient variation in *Doenjang* stews collected from different restaurants

Table 2 lists ingredient characteristics of *Doenjang* stews collected from different restaurants. DS3 exhibited the most diverse ingredients, whereas DS4 exhibited the least diverse ingredients. DS1 contained five ingredients: mushroom, tofu, green onion, young squash, and clams. DS2 also contained five ingredients: potato, tofu, green onion, onion, and young squash; DS3 contained eight ingredients: mushroom, potato, tofu, green onion, onion, young squash, green pepper, red pepper, and clams; DS4 comprised four ingredients: tofu, green onion, onion, and young squash. All DS samples contained three similar ingredients: tofu, green onion, and young squash. Green onion was exclusively found in DS3. Among all ingredients, tofu accounted for the heaviest (by weight) ingredient in all DS samples.

Differences in the total weight of one serving size were observed among four samples. DS4 exhibited the highest weight of 791.4 g, whereas DS1 exhibited the lowest amount (330.0 g) per serving size, exhibiting a significant difference (P<0.05). The weights of one serving size in DS2 and DS3 were 432.4 g and 516.5 g, respectively. The stock-to-ingredient ratios of DS1, DS2, and DS3 were 1.0, 1.1, and 0.8, respectively, whereas DS4 was 1.6, significantly greater than those of the other samples (P<0.05). Considering that the weight of one serving size of DS4 was the highest, the majority accounted for DS4, possibly attributed to the stock weight rather than the ingredients. The stock-to-ingredient ratio of DS3 was 0.8, which was the lowest (P<0.05). Notably, DS3 contained the most diverse ingredients in the recipe; therefore, this factor possibly affects the low stock-to-ingredient ratio of DS3.

As expected from salinity variations, daily variations in ingredients were observed. Tofu, young squash, and green onion were included in all samples. For DS1 samples, the deviation of tofu was highest (59.7~86.8; data not shown). In addition, the weight of tofu was the high-

Table 2. Ingredient characteristics of *Doenjang* stews (DSs) collected from different restaurants

Characteristic	DS1	DS2	DS3	DS4
Mushroom (g/100 g)	4.7±1.0^{b}	0^{c}	8.1±1.1^{a}	0^{c}
Potato (g/100 g)	0^{b}	6.3±1.0^{a}	0^{b}	0^{b}
Tofu (g/100 g)	23.5±5.03^{a}	11.3±1.3^{bc}	11.1±1.1^{c}	16.5±1.6^{b}
Green onion (g/100 g)	3.4±1.4^{b}	2.8±1.1^{b}	7.0±2.9^{a}	3.4±2.1^{b}
Onion (g/100 g)	0^{b}	6.7±1.0^{a}	6.8±3.1^{a}	6.0±0.8^{a}
Young squash (g/100 g)	9.6±1.8^{ab}	10.8±1.79^{a}	5.8±2.9^{bc}	4.8±1.2^{c}
Green onion (g/100 g)	0^{b}	0^{b}	8.2±3.2^{a}	0^{b}
Clam (g/100 g)	1.5±0.5^{b}	0^{c}	2.5±0.9^{a}	0^{c}
Total weight (g)	330.0±23.0^{c}	432.4±31.9^{bc}	516.5±41.2^{b}	791.4±94.9^{a}
Total stock (mL)	173.3±20.8^{b}	226.7±28.4^{b}	251.7±42.5^{b}	490.0±78.1^{a}
Total ingredient (g)	170.9±13.2^{b}	210.6±31.3^{b}	298.1±31.8^{a}	305.9±25.2^{a}
Stock-to-ingredient ratio	1.0±0.2^{b}	1.1±0.2^{b}	0.8±0.1^{b}	1.6±0.2^{a}

Data are presented as mean±SD of triplicate analyses.
Numbers in a row with different letters (a-c) represent significant differences (P<0.05).

est compared to the weight of other ingredients. The amount of young squash in DS2 was the highest compared to other samples (47.0 g). In the case of DS3, the most diverse ingredients were included in this sample than others. Red pepper that was excluded from other samples was included in DS3. The standard deviation of the amount of onion in DS3 was significantly high (21.9 ~58.5; data not shown). However, unlike DS3, DS4 had the least number of ingredients. In DS4, the average weight of tofu, young squash, and onion excluding green onions was the largest compared to other samples.

The result indicates that cooks and chefs working in the restaurant does not follow the fixed recipe. Another possibility is that *Doenjang* stew was made in a large pot ahead of time, and ingredients were unevenly scooped out for one serving size. The difference between restaurant- and home-made *Doenjang* stews is that restaurants cook in a large pot for multiple servings, whereas only one or two serving sizes are typically prepared at home. Regardless, ingredient variations, such as types of ingredients included in different restaurants, types, and numbers of ingredients used within a restaurant, were observed in all *Doenjang* stew samples in this study.

Consumer acceptance testing results

Table 3 lists the results from the consumer acceptance testing of the four *Doenjang* stew samples. As participants were recruited from a college town, most were college students in their 20s (96.8%), with a monthly income of less than $1,000 (88.0%). In addition, participants were frequent *Doenjang* consumers; that is, ~89% of the participants consumed *Doenjang* either at home or in a restaurant at least once every 2 to 3 months.

Differences in several liking attributes, such as appearance, overall, and salty taste liking, were observed between samples (P<0.05). The appearance liking of DS3 was significantly less than that of DS1 (P<0.05), whereas significant differences were not observed between other samples (DS2 and DS4; P>0.05). DS4 exhibited the highest overall liking score (5.8), which was significantly greater than that of DS1 (P<0.05). Similar to the overall liking, DS4 exhibited the highest salty taste liking. Notably, the salty taste liking of DS4 was significantly greater than that of DS3 (P<0.05). Simultaneously, the salinity values of DS3 and DS4 were the same (1.3%), which is similar to those reported previously for the salinity of *Doenjang* stew that appeals to Korean consumers (Chon and Kim, 2020). Differences between DS3 and DS4 were

Table 3. Consumer acceptance testing for four different *Doenjang* stews (DSs; N=79)

Consumer acceptance	DS1	DS2	DS3	DS4
Appearance liking	5.7±1.4^{a}	5.3±1.5^{ab}	5.2±1.9^{b}	5.5±1.5^{ab}
Color liking	5.8±1.4^{a}	5.3±1.6^{a}	5.4±1.8^{a}	5.5±1.6^{a}
Overall liking	5.2±2.1^{b}	5.7±2.0^{ab}	5.3±2.0^{ab}	5.8±1.7^{a}
Flavor liking	5.2±1.7^{a}	5.6±1.4^{a}	5.4±1.7^{a}	5.4±1.5^{a}
Mouthfeel liking	5.7±1.5^{a}	5.7±1.3^{a}	5.4±1.5^{a}	5.7±1.4^{a}
Salty taste liking	5.2±1.6^{ab}	5.4±1.7^{ab}	4.9±1.9^{b}	5.7±1.6^{a}
Sweet taste liking	5.4±1.4^{a}	5.5±1.3^{a}	5.2±1.5^{a}	5.6±1.5^{a}
Umami taste liking	5.4±1.6^{a}	5.6±1.6^{a}	5.5±1.7^{a}	5.7±1.6^{a}

Liking attributes were rated on a 9-point hedonic scale with 1 = dislike extremely and 9 = like extremely.
Data are presented as mean±SD of 79 consumers.
Numbers in a row with different letters (a,b) represent significant differences (P<0.05).

observed in terms of the stock-to-ingredient ratio (Table 2) due to DS3 exhibiting the lowest stock-to-ingredient ratio (0.8). In contrast, DS4 showed the highest value (1.6), indicating that more ingredients were present in the recipe of DS3, and more stock was present in the recipe of DS4. Based on the consumer acceptance testing results, the consumer liking of *Doenjang* stew may not originate from the ingredients included in the recipe. Instead, compared with ingredients in *Doenjang* stew, more stock in *Doenjang* stew possibly affected the higher overall liking and salty taste liking with the same salinity of *Doenjang* stew. The low salty taste liking of DS3 can possibly be attributed to the presence of a spicy ingredient based on consumer responses collected from open-ended questions (data not shown). Of the total participants, 62.9% responded that DS3 was "too salty" and that the "DS3 sample was too spicy (22%)", suggesting that the presence of a "spicy" ingredient in DS3 is falsely induce a high salty taste intensity in DS3, influencing the lower salty taste liking of DS3. Respondents thought the DS3 sample was spicy due to garlic or green onions added to the broth. Alternatively, it is not shown in the table, but red pepper powder may have been added to the stock of DS3.

This study monitored ingredient and salinity variations in *Doenjang* stew sold near the college campus, and the salinity of *Doenjang* stew appealing to college students was estimated. Based on this study, the salinity (%) of *Doenjang* stews collected from four restaurants on different days ranged from 1.2% to 1.7%, greater than the Korean government recommended (0.8%). Ingredient variations within restaurants were observed ($P<0.05$), showing significant differences in ingredient types and amounts as observed between restaurants, suggesting that the standard recipe for *Doenjang* stew is not followed in practice. The salinity of greater than 1.3% for *Doenjang* stew was most liked, whereas consumers least liked that of 1.2%. At the same salinity value (1.3%), a high amount of stock in the *Doenjang* stew recipe was preferred to a greater extent than a higher number of ingredients, suggesting that various ingredients included in the recipe do not necessarily increase consumer acceptance of *Doenjang* stew. The limitation of this study was the number of *Doenjang* stews included in this study, as *Doenjang* stews collected from four different restaurants near one campus town may not represent the *Doenjang* stews served in the Korean market. Future studies may require more *Doenjang* stew samples collected from different restaurants located in representative locations in Korea. Additionally, consumer acceptance testing with greater numbers of participants may be needed. Therefore, this can be conducted in a future study.

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AUTHOR DISCLOSURE STATEMENT

The authors declare no conflict of interest.

AUTHOR CONTRIBUTIONS

Data collection and writing the article: JSH. Critical revision and final approval of the article: MKK.

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