## REGULAR ARTICLE

# Consumer perception of bread depending on wheat origin in relation to physicochemical characteristics of wheat flour

Mi Jeong Kim[1†], Han Sub Kwak[1†], Hee Yeon Jung[1], Min Jung Lee[1], Oui-Woung Kim[2], Hoon Kim[2], San Sook Kim[1*]

[1]Research Group of Cognition and Sensory Perception, Korea Food Research Institute, Seongnam-si 13539, Republic of Korea, [2]Research Group of Smart Food Distribution System, Korea Food Research Institute, Seongnam-si 13539, Republic of Korea
[†]These authors are equally contributed to this study.

## ABSTRACT

The objective was to investigate the influence of wheat origin on overall acceptance (OA), purchase intent (PI), and willingness to pay (WTP) of bread in relation to physicochemical characteristics of Korean and imported wheat flours. The specific volumes (SV) of bread made with imported wheat flour were correlated with protein (r = 0.893), gluten (r = 0.843), and extensibility (r = 0.879). However, relatively low correlations were found between SV and protein (r = 0.528), gluten (r = 0.459), and extensibility (r = 0.413) in Korean wheat flour. The bread prepared with Korean wheat JK_1, imported NS and HRW_1 wheats showed higher OA, PI, and WTP than others in a blind consumer test. When the origins of the wheat flour were informed to Korean consumers, the WTP for breads prepared with JK_1 was increased significantly, while the OA was slightly increased for bread made with Korean wheat flour. Overall results of this study showed that Korean consumers exhibited a preference for Korean wheat products and willingness to pay more money than those from the imported wheat despite inconsistencies of wheat quality in SRC profile and dough properties found in the Korean wheat flours.

Keywords: Bread quality; Country of origin of wheat; Purchase intent; Wheat flour; Willingness to pay

## INTRODUCTION

Wheat (*Triticum aestivum* L.) is one of the major grains in the world (Van Hung et al., 2009). Wheat accounted for approximately 28% of world total grain consumption in 2014 (FAO, 2015). In Korea, wheat is the second mostly consumed grain after rice, and annual wheat consumption per capita has increased from 26.1 kg in 1970 to 31.7 kg in 2014 (MAFRA, 2015). Due to geological and weather issues, wheat has not been cultivated widely in Korea; therefore approximately 99% of wheat consumed in the country is imported mainly from the United States of America (USA) and Australia (KCS, 2015; MAFRA, 2015). However, consumers have begun to pay attention to locally grown wheat due to food preservatives used in wheat kernel prior to international transportation (Jin and Kim, 2011).

Consumer perception may be affected by the country of origin (CO) as well as the quality status of the food product.

The effect of the CO on consumer perception in regard to willingness to pay (WTP) and purchase intent (PI) has been studied for a wide range of foods (Balestrini and Gamble, 2006; Schnettler et al., 2008). Previous studies have shown that consumers tend to use the CO as a cue to make decisions for the purchase of products with or without other product information (Balestrini and Gamble, 2006; Schnettler et al., 2008). In addition, several studies have reported that consumer ethnocentrism has a positive influence on consumer preference for domestic products (Jang et al., 2012; Juric and Worsley, 1998). Jang et al. (2012) investigated consumer perception of rice samples with different COs. They found that the PI was higher for all domestic samples in an informed test compared to a blind test, demonstrating that consumers exhibited loyalty for their domestic rice. Juric and Worsley (1998) showed that consumer ethnocentrism might play a key role in the purchase of foreign versus domestic products in New Zealand. Despite these previous studies,

information on consumer perception of bread in relation to the physicochemical characteristics of flour with different origins is limited. Therefore, the objective was to investigate the influence of wheat origins on consumer perceptions of bread in relation to physicochemical characteristics of Korean and imported wheat flours.

## MATERIALS AND METHODS

### Wheat flour samples

Six Korean wheat samples and eight imported wheat samples (five from the USA, two from Australia, and one from Canada) were used in this study (Table 1). Korean wheat samples consisted of two major cultivars, Keumkang (KK) and Jokyung (JK), widely grown in Korea. Four KK samples and two JK samples were obtained from six different cultivated sites in Korea. All of the wheat samples were provided by CJ Cheiljedang Co., Ltd. (Seoul, Korea), one of the largest flour milling companies in Korea. Wheat kernels were tempered overnight to 16% moisture content and then milled using a Bühler experimental mill (Bühler, Uzwil, Switzerland). Wheat flour with 60% milling yield was tightly packed in polyethylene bags and stored at 0°C until used.

### Contents of protein and gluten, and solvent retention capacity (SRC) profile of flour

Protein content was determined using American Association of Cereal Chemists (AACC) approved method 08-01 (AACC 2000). Wet gluten content was measured using a Glutomatic System (Glutomatic 2200, Stockholm, Sweden) according to the procedure described by Ohm and Chung (1999). The gluten content was isolated from 10 g of flour with 2% NaCl buffer using a Glutomatic 2200 Automatic

**Table 1: Specification of the wheat samples used in this study**

| Country of origin (cultivated region) | Class/cultivar | Abbreviation |
|---|---|---|
| Korea (Gunsan) | Keumkang | KK_1 |
| Korea (Gunsan) | Jokyoung | JK_1 |
| Korea (Jeongeup) | Keumkang | KK_2 |
| Korea (Gwangju) | Keumkang | KK_3 |
| Korea (Hapcheon) | Keumkang | KK_4 |
| Korea (Hapcheon) | Jokyoung | JK_2 |
| United State of America | Northern spring | NS |
| United State of America | Hard red winter wheat | HRW_1 |
| United State of America | Dark northern spring | DNS |
| United State of America | Hard red winter wheat | HRW_2 |
| United State of America | Soft white 10.5 | SW10.5 |
| Australia | Australian hard wheat | AH |
| Australia | Australian standard white wheat | ASW |
| Canada | Canada western red spring | CWRS |

Washing System. The SRC profile was measured according to Duyvejonck et al. (2011), which is a modification of AACC method 56-11A (AACC, 2000). The SRC profile consists of its water retention capacity (WRC), sodium carbonate SRC (SCSRC), sucrose SRC (SuSRC), and lactic acid SRC (LASRC) values. Briefly, 25 mL of 5%(v/v) sodium carbonate solution, 50%(w/w) sugar solution, 5%(w/w) lactic acid solution ord distilled water, and 5 g of flour were mixed for 20 min, and then centrifuged at 6000×g. The SRC profiles were obtained from the weight of the precipitate.

### Extensibility and resistance of dough

Dough extensibility and resistance were determined using a texture analyzer (TA, TA-HD plus, Stable Micro Systems, Ltd., Haslemere, UK) according to the procedure described by Barros et al. (2010) with some modifications of sample preparation. Briefly, wheat flour and water (37% of flour weights) were mixed to form dough and then kept for 30 minutes at room temperature (23 ± 1°C). The dough was then placed into Teflon molds to prepare strips (5 × 52 × 3 mm, width × length × height, respectively). The strips were covered with plastic wrap to prevent drying for 40 minutes. Each strip was placed on a flat metal plate, and resistance and extensibility in tension mode were measured using a probe (Kieffer dough and gluten extensibility rig) at a pre-test speed of 2.0 mm/s, a test speed of 3.3 mm/s, a post-test speed of 10.0 mm/s, and a distance of 75 mm.

### Preparation, specific volume (SV), and hardness of yeast-leavened bread

Yeast-leavened bread was prepared using AACC Method 10-10B (AACC, 2000) with some modifications of the ingredients as follows: flour, 100%; dry yeast, 2.12%; sugar 6%; salt, 1.5%; baking improver, 0.2%; and shortening, 3% (flour weight basis). The water content of each wheat sample was determined by the results of Farinograph absorption (data not shown). The SV (mL/g) of bread was determined on the day of baking using a VolScan Profiler (Stable Micro Systems, Ltd., Haslemere, UK) and was calculated by dividing the volume of the bread by its weight. The hardness of bread was measured as described by Bourne (1978). Two layers of bread crumbs (25 × 25 × 19 mm, width × length × height/piece, respectively) were compressed with a plunger (50 mm diameter) at a crosshead speed of 10 mm/s using a TA (TA-XT plus, Stable Micro Systems, Ltd., Haslemere, UK). Three replications were performed, and each replication was averaged from eight times of texture measurements.

### Overall acceptance (OA), PI, and WTP for bread

A total of 104 subjects (age 20–49 years) voluntarily participated in the consumer acceptance test. They did not have any issues in health and consuming bread. The

352

Emir. J. Food Agric ● Vol 29 ● Issue 5 ● 2017

consumer test for the 14 breads was performed over two days at the Korea Food Research Institute (Seongnam-si, Korea). The samples were randomized by the sensory data collection program (Custom-made, Korea Food Research Institute, Seongnam-si, Korea) to minimize first-serving order bias. The first seven samples from the randomization were evaluated on the first day, and then the other seven samples were evaluated on the second day.

During the consumer acceptance test, the samples were presented without any information to the consumers. Consumers were asked to evaluate the OA, PI, and WTP of the breads. OA and PI were determined using a 9-point hedonic scale (1 = dislike extremely, 5 = neither like nor dislike, and 9 = like extremely) and a 5-point category scale (1 = definitely not purchase, 3 = neither purchase nor not purchase, and 5 = definitely purchase), respectively. The PI was calculated as the percentage of consumers who checked "definitely purchase" and "probably purchase". Right after the blind test, the consumers evaluated breads with information on the flour's origin and the price range of bread in the market. The price range for Korean wheat bread was $2.66–6.20 per 400 g package, and the range for imported wheat bread was $1.77–2.66 per 400 g package. The consumers were once again asked to evaluate OA, PI, and WTP. For consumer testing, four pieces of bread samples (20 × 20 × 19 mm, width × length × height, respectively) were presented on a white dish (14 cm, diameter) with a three-digit random code. All of the consumer tests were conducted in individual booths under incandescent lighting. Water was provided to panelists for rinsing the mouth before tasting a sample and in between samples. Panelists took a 1-min forced break after evaluating each sample to minimize sensory fatigue. The samples were served in a monadic manner.

## Statistical analysis

Analysis of variance (ANOVA) was performed to determine differences among the samples using Statistical Analysis System 9.2 software (SAS Institute, Cary, USA). When significant differences among samples were found, the Student Newan-Keul's (SNK) multiple comparison was performed to separate the means at $P < 0.05$. To determine the relationship between physicochemical characteristics of wheat from different origins, Pearson's correlation analysis was performed. The principal component analysis (PCA) was carried out to summarize the relationship between the physicochemical properties of wheat flour and consumer perception of breads using XLSTAT software (Addinsoft, Paris, France).

## RESULTS AND DISCUSSION

### The content of protein and wet gluten, and SRC profile of flour

The protein and gluten contents of the 14 wheat flours are shown in Table 2. The 14 wheat flour samples were significantly different in protein and gluten contents (both $P < 0.001$). The protein and gluten contents of the 14 samples were in the range of 8.0–13.7% and 22.4–39.8%, respectively. As reported by Anjum and Walker (2000), the protein content of imported wheat flour in this study varied with cultivar or class type of wheat (Table 2). On the other hand, a wide range of protein (8.9–11.4%) and gluten content (23.7–35.1%) were observed among Korean wheat cultivar KK grown in different regions. Maghirang et al. (2006) compared the quality characteristics

**Table 2: The contents of protein[1] and wet gluten[2] and solvent retention capacity[1] profiles of wheat flour from different origins**

| Sample[3] | Protein[4]***[5] (%) | Wet gluten[4]*** (%) | Solvent retention capacity (SRC) [4] (%) | | | |
|---|---|---|---|---|---|---|
| | | | WRC*** | SCSRC*** | SuSRC*** | LASRC*** |
| KK_1 | 8.8[k6] | 24.0[ef] | 58.1[e] | 70.3[h] | 87.2[de] | 95.6[f] |
| JK_1 | 9.7[i] | 26.5[d] | 58.2[e] | 74.0[fg] | 91.8[c] | 101.1[e] |
| KK_2 | 11.4[d] | 35.1[b] | 61.6[c] | 76.1[ef] | 90.1[cd] | 101.5[e] |
| KK_3 | 9.3[j] | 23.7[ef] | 53.4[f] | 62.1[j] | 79.9[g] | 88.8[g] |
| KK_4 | 11.2[e] | 31.9[c] | 62.1[c] | 77.1[ef] | 91.8[c] | 102.3[e] |
| JK_2 | 10.0[h] | 28.2[d] | 53.6[f] | 66.1[i] | 82.5[f] | 97.2[f] |
| NS | 12.2[c] | 33.4[bc] | 65.9[a] | 93.8[a] | 106.2[a] | 123.6[a] |
| HRW_1 | 9.9[h] | 24.8[e] | 62.2[c] | 89.1[b] | 99.6[b] | 114.2[b] |
| DNS | 12.7[b] | 35.2[b] | 63.5[b] | 81.7[d] | 91.2[c] | 111.2[c] |
| HRW_2 | 10.3[g] | 26.9[d] | 61.3[c] | 78.6[e] | 89.2[cd] | 102.6[e] |
| SW10.5 | 9.0[m] | 22.4[f] | 48.2[g] | 57.3[k] | 75.5[h] | 74.9[h] |
| AH | 10.5[f] | 27.9[d] | 60.1[d] | 85.5[c] | 90.0[cd] | 108.3[d] |
| ASW | 8.7[l] | 24.3[ef] | 57.6[e] | 71.2[gh] | 85.0[e] | 95.3[f] |
| CWRS | 13.7[a] | 39.8[a] | 61.7[c] | 82.7[cd] | 91.7[c] | 107.7[d] |

1) Mean values of three replications, 2) Mean values of four replications, 3) Identification of samples is described in Table 1, 4) Based on 14% moisture content, WRC, SCSRC, SuSRC, and LASRC meant water retention capacity, Sodium Carbonate SRC, Sucrose SRC, and Lactic Acid SRC, respectively, 5) *** meant significantly different at $P$=0.001, 6) Values with same alphabets within a column are not significantly different at $P$<0.05 according to Student Newan-Keulis multiple comparison test

and breadmaking functionality of 100 hard red winter (HRW) and 100 hard red spring (HRS) wheat samples and reported that the mean protein and wet gluten contents of the HRS wheat flour samples (13.2 ± 1.53% of protein and 36.2% of gluten) were higher than those of the HRW samples (11.3 ± 1.6% of protein and 30.3% of gluten) and that both wheat classes are usually considered suitable for yeast-leavened breads. The results of this study confirmed the reports of Maghirang et al. (2006) showing higher protein and gluten contents in HRS such as NS, DNS, and CRWS (12.2–13.7% of protein and 33.43–39.75% of gluten) than in HRW_1 and HRW_2 (9.9–10.3% of protein and 24.83–26.92% of gluten). The other Korean wheat cultivar, JK, exhibited protein and gluten contents similar to those of HRW wheat, suggesting that JK is comparable to HRW wheat.

The SRC properties are generally used to evaluate wheat flour quality for commercial baking (Duyvejonck et al., 2011). The SRC profiles are presented in Table 2, and the 14 samples were significantly different at $P < 0.001$ across the samples in WRC, SCSRC, SuSRC, and LASRC. The WRC and LASRC of the 14 samples were in the range of 48.2–65.9% and 74.9–123.6%, respectively (Table 2). The WRC and LASRC values among SRC profiles were related to production of the bread (Duyvejonck et al., 2011). The hard type wheat from the imported wheat flours tended to have higher WRC and LASRC than soft wheat (SW10.5). For Korean wheat flour, KK samples showed large variations in WRC (53.4–62.1%) and LASRC (88.8–102.3%). JK samples had lower variations; however, the percentage values were lower than those of imported wheat samples in general, except SW10.5. Large variations of a single variety, KK, confirmed the physicochemical results in Table 2 may generate inconsistent quality issues

for industry. SCSRC is linearly related with the level of damaged starch (Gaines, 2000). More than 80% of SCSRC was only observed in the imported wheat flour samples (five out of eight samples), while Korean wheat samples showed 62.1–77.1%. More damaged starch was shown in the imported wheat flour than in Korean wheat. SuSRC range for Korean wheat flour (79.9–91.8%) was narrower than the imported wheat flour (75.5–106.2%). The NS and HRW_1 had significantly higher values than Korean wheat flour ($P < 0.05$).

## Dough and bread properties

The result of extensibility and resistance of the doughs are presented in Table 3. The extensibility and resistance of the 14 wheat flours differed significantly (both $P < 0.001$) and were in the range of 16.4–44.4 mm and 0.53–1.05 N, respectively. The dough extensibility values (36.5–44.4 mm) of flour prepared from the HRS (CWRS, NS, and DNS) were higher than those of the SW10.5 (16.4 mm) or ASW (19.7 mm). Nash et al. (2006) and Caffe-Treml et al. (2011) reported that increased dough extensibility enhanced bread rising to form a larger loft volume. The results in this study showed higher dough extensibility and lower resistance for flour from the hard wheat than the soft wheat type, with correspondingly higher expected bread volumes (Table 3). Between Korean wheat flour, the KK cultivar showed a wider range of extensibility (19.1–32.5 mm) and resistance (0.69–1.05 N) than JK cultivar. The ranges of extensibility and resistance for JK were 32.5–34.8 mm and 0.67–0.69 N, respectively. Considering that the dough extensibility of HRW was in the range of 27.3–32.5 mm, the JK samples were comparable to HRW for making bread. The dough resistance values tended to decrease with increasing dough extensibility in general, as reported by Nash et al. (2006).

**Table 3: Extensibility and resistance for dough properties, and hardness and specific volume for bread properties**

| Sample[2] | Dough[1] | | Bread[1] | |
|---|---|---|---|---|
| | Extensibility***[3] (mm) | Resistance*** (N) | Hardness*** (N) | Specific volume*** (mL/g) |
| KK_1 | 21.9[f4)] | 0.76[cd] | 1.29[c] | 3.89[d] |
| JK_1 | 32.5[d] | 0.69[e] | 1.13[c] | 4.26[abcd] |
| KK_2 | 31.3[d] | 0.70[de] | 2.86[a] | 4.43[abcd] |
| KK_3 | 19.1[fg] | 1.05[a] | 1.31[c] | 4.38[abcd] |
| KK_4 | 32.1[d] | 0.69[e] | 2.45[ab] | 4.24[abcd] |
| JK_2 | 34.8[bcd] | 0.67[e] | 1.38[c] | 4.41[abcd] |
| NS | 38.1[b] | 0.71[de] | 1.14[c] | 4.79[a] |
| HRW_1 | 32.5[d] | 0.66[e] | 1.99[bc] | 4.36[abcd] |
| DNS | 36.5[bc] | 0.83[bc] | 1.52[c] | 4.54[abc] |
| HRW_2 | 27.3[e] | 0.85[b] | 1.63[c] | 4.30[abcd] |
| SW10.5 | 16.4[h] | 0.65[e] | 3.06[a] | 4.12[bcd] |
| AH | 33.7[cd] | 0.69[e] | 1.60[c] | 4.23[abcd] |
| ASW | 19.7[fg] | 0.80[bc] | 1.97[bc] | 3.97[cd] |
| CWRS | 44.4[a] | 0.53[f] | 1.88[bc] | 4.67[ab] |

1) Mean values of three replications, 2) Identification of samples is described in Table 1, 3) *** meant significantly different at $P$=0.001, 4) Values with same alphabets within a column are not significantly different at $P$<0.05 according to Student Newan-Keulis multiple comparison test

The main parameters of bread quality are low crumb hardness and high SV (Steffolani et al., 2012). The hardness and SV of breads prepared with the 14 samples are presented in Table 3. The 14 breads differed significantly in SV ($P < 0.001$) and hardness ($P < 0.001$) (Table 3). The hardness and SV of the breads were in the range of 1.13–3.06 N and 3.89–4.79 mL/g, respectively. Rozylo et al. (2014) reported that decreased hardness of bread correlated strongly with increased bread loaf volume. Among Korean wheat flour breads, JK_1, JK_2, and KK_3 showed lower hardness and higher SV than KK_1 and KK_2. Specifically, the hardness and SV of bread prepared with the JK_1 wheat flour were statistically similar to the hardness and SV of bread made with NS wheat (Table 3). KK samples from four different regions in Korea showed a large variation in the hardness of the bread. This may imply a quality control issue for industry use. The bread made with the NS had low hardness (1.14 N) and high SV (4.79 mL/g). Among the breads made from the imported wheat flour, ASW and SW10.5 had higher hardness and/or lower SV than others, implying non-suitability for bread making.

## Relationship between flour, dough, and bread parameters

The correlation coefficients (r) between the protein or SV and properties of flour, dough, and bread prepared with 14 wheat origins are summarized in Table 4. The protein was highly correlated ($P < 0.05$) with gluten (r = 0.960), WRC (r = 0.743), LASRC (r = 0.719), extensibility (r = 0.883), and SV (r = 0.817). The SV was highly correlated with protein (r = 0.817), gluten (r = 0.739), and extensibility (r = 0.758). The extensibility of dough was highly correlated with protein (r = 0.946) and SV (r = 0.879) in imported wheat; however, this trend was not observed in Korean wheat. Protein was highly correlated with hardness of bread

(r = 0.912) in Korean wheat indicating a difference in protein quality between the imported wheat and Korean wheat samples used in this study. Lin et al. (2012) and Schmiele et al. (2012) reported a high correlation between SV of bread and dough extensibility. In addition, Lin et al. (2012) showed that bread made with flour containing high gluten content exhibited the highest SV. The results of correlation analysis by origins of the wheat (Korean vs. imported) showed that correlation coefficients between bread volume and protein, gluten, and dough extensibility were much lower in Korean wheat (r = 0.528, 0.459, and 0.413, respectively) than those in imported wheat (r = 0.893, 0.843, and 0.878, respectively). The above results may imply that the baking quality of imported wheat samples was better than that of Korean wheat samples other than ASW and SW10.5, which were the multipurpose wheat flour.

## Consumer testing of breads

The OA and the PI (%) of the 14 breads are shown in Table 5. The mean separation by the SNK multiple comparison test was similar between the blind and informed tests. The bread baked with the NS wheat exhibited the highest OA, followed by HRW_1 and JK_1 in a blind test. OA of bread made with the KK_2 was the lowest among the breads tested in this study. Highly accepted samples (JK_1 and KK_4) among Korean wheat flour breads increased their OA rating more than the lower accepted samples (KK_2 and KK_3) in the informed test ($P < 0.05$). The acceptance ratings for highly samples were significantly increased by the informed test ($P < 0.01$). KK variety showed large variations in OA depending on the growing regions along with the physicochemical characteristics (Table 5).

Information for flour origins did not affect either positively or negatively in general for the breads made by imported

**Table 4: Correlation coefficients (r) between protein or specific volume and properties of flour, dough, and bread depending on wheat origins**

| Variable | Protein | | | Specific volume | | |
|---|---|---|---|---|---|---|
| | Korean (r) | Imported (r) | Total (r) | Korean (r) | Imported (r) | Total (r) |
| Flour | | | | | | |
| Protein | 1 | 1 | 1 | 0.528 | 0.893** | 0.817*** |
| Gluten | 0.972***[2] | 0.977*** | 0.960*** | 0.459 | 0.843** | 0.739** |
| WRC[1] | 0.678 | 0.750* | 0.743** | -0.194 | 0.705 | 0.495 |
| LASRC[1] | 0.707 | 0.709* | 0.719** | 0.035 | 0.727* | 0.624** |
| SCSRC[1] | 0.678 | 0.661 | 0.674* | -0.137 | 0.691 | 0.541* |
| SuSRC[1] | 0.519 | 0.587 | 0.598* | -0.236 | 0.733* | 0.542* |
| Dough | | | | | | |
| Extensibility | 0.528 | 0.946*** | 0.883*** | 0.413 | 0.879** | 0.758** |
| Resistance | -0.480 | -0.220 | -0.307 | 0.072 | -0.289 | -0.171 |
| Bread | | | | | | |
| Hardness | 0.912* | -0.659 | -0.117 | 0.319 | -0.591 | -0.194 |
| Specific volume | 0.528 | 0.893** | 0.817** | 1 | 1 | 1 |

1) Based on 14% moisture content WRC, SCSRC and SuSRC, and LASRC meant water retention capacity, Sodium Carbonate SRC, Sucrose SRC, and Lactic Acid SRC, respectively, 2) *,**, and *** represents significant levels at *P*<0.05, *P*<0.01, and *P*<0.001, respectively

wheat flour (Table 5). Compared with Korean wheat breads, highly accepted imported breads (NS and HRW_1) increased their OA rating in the informed test. However, when the origin of the wheat was provided, OA for most of the imported samples (DNS, HRW_2, AH, ASW, and SW10.5) was decreased. Only NS was significantly increased by the informed test (*P*<0.05). Low variations between the blind and informed tests for the imported wheat might be explained by the consumers' indifference about the imported wheat since most (> 98%) of the wheat in Korea is imported in comparison with the opposite case of the rice (Jang et al., 2012).

The tendency of PI was similar to OA, indicating consistency in consumer evaluation. Bower et al. (2003) reported that PI was presumed to be based on sensory liking alone, and that PI based on a sensory test was highly correlated with OA in the case of a blind test. The results of this study are in line with the report by Bower et al. (2003) by presenting a high correlation (r = 0.968, data not shown) between OA and PI in the blind test. As shown in Table 5, the percentages of consumers who are willing to buy the breads made with Korean wheat tended to increase when the origin of the wheat was informed. The PI increased more in the highly accepted samples (JK_1 and KK_4) among the breads made of Korean wheat flour, while the lower accepted samples showed slight increases (1.0~6.0%) between the blind and informed test. Juric and Worsley (1998) showed that consumer ethnocentrism might play a significant role in the purchase of imported products compared to domestic ones. Consumer ethnocentrism to the domestic and imported food products was higher than the other product such as car, TV, and cloths among the British (Balabanis and Diamantopoulos, 2004). For agricultural products Koreans preferred domestic products and considered the country of origin and quality as the reasons of their choice (Rhew, 2008). Therefore, it can be inferred that the ethnocentrism played a key role in increasing the PI of the bread made by domestic wheat flour. Similar results with the findings of this study were also reported by Jang et al. (2012) that the PI for domestic rice samples was higher in an informed test than in a blind test. In addition, the OA for highly accepted samples (JK_1, NS, and HRW_1) showed their OA increased significantly (*P* < 0.05) for JK_1 and NS. Consumers seemed to rate higher when they identify the information for their product (Jang et al., 2012).

The differences in WTP between the informed and the blind tests (WTP informed test, WTP blind test) of the 14 breads are shown in Table 6. In the blind test, the price for Korean wheat flour samples ($1.88–2.58 per 400 g package) and the imported wheat flour samples ($1.94–2.54) showed similar price ranges. The price ranges in the informed test,

**Table 5: Overall acceptance and purchase intent (%) of the bread made by Korean and imported wheat flour**

| Sample[1] | Overall acceptance | | | Purchase intent (%)[2] | |
|---|---|---|---|---|---|
| | Blind test | Informed test | *P*-value | Blind test | Informed test |
| KK_1 | 5.2[cd] | 5.4[c] | 0.37 | 28.4 | 31.4 |
| JK_1 | 6.5[a] | 7.1[a] | <0.001 | 64.0 | 72.0 |
| KK_2 | 4.2[f] | 4.2[d] | 0.97 | 12.7 | 13.7 |
| KK_3 | 4.6[ef] | 4.7[d] | 0.54 | 19.6 | 22.5 |
| KK_4 | 5.8[b] | 6.2[b] | 0.002 | 38.0 | 48.0 |
| JK_2 | 5.2[cd] | 5.4[c] | 0.11 | 28.0 | 34.0 |
| NS | 6.7[a] | 7.1[a] | 0.04 | 66.7 | 70.6 |
| HRW_1 | 6.6[a] | 6.7[a] | 0.28 | 64.7 | 62.7 |
| DNS | 4.9[de] | 4.8[cd] | 0.77 | 18.6 | 22.5 |
| HRW_2 | 4.5[ef] | 4.4[d] | 0.61 | 17.6 | 16.7 |
| SW10.5 | 5.5[bc] | 5.3[c] | 0.40 | 33.0 | 33.0 |
| AH | 5.5[bc] | 5.4[c] | 0.64 | 42.2 | 47.1 |
| ASW | 5.5[bc] | 5.5[c] | 0.85 | 27.0 | 26.0 |
| CWRS | 4.6[f] | 4.6[d] | 0.75 | 17.0 | 17.0 |

1) Identification of samples was described in Table 1, 2) Purchase intent in this table is the proportion of the consumers who marked 'definitely purchase' and 'probably purchase' on the purchase intent scale

**Table 6: Difference between blind test and informed tests in willingness to pay for bread**

| Sample[1] | Willingness to pay (US $/400 g package)[2] | | Difference |
|---|---|---|---|
| | Blind test (B) | Informed test (I) | I - B |
| KK_1 | 2.19[cde3] | 2.53[bc] | 0.34*** |
| JK_1 | 2.58[a] | 2.95[a] | 0.37** |
| KK_2 | 2.88[f] | 2.21[de] | 0.33*** |
| KK_3 | 2.00[def] | 2.38[cd] | 0.38*** |
| KK_4 | 2.39[abc] | 2.72[b] | 0.33*** |
| JK_2 | 2.31[bc] | 2.62[bc] | 0.32** |
| NS | 2.51[ab] | 2.41[cd] | -0.10 |
| HRW_1 | 2.54[a] | 2.41[cd] | -0.14 |
| DNS | 2.23[cde] | 2.12[ef] | -0.12 |
| HRW_2 | 2.22[cde] | 2.13[ef] | -0.09 |
| SW10.5 | 2.01[def] | 1.96[ef] | -0.05 |
| AH | 1.98[ef] | 1.96[ef] | -0.02 |
| ASW | 1.94[f] | 1.92[f] | -0.02 |
| CWRS | 2.25[cd] | 2.14[ef] | -0.11 |

1) Identification of samples was described in Table 1, 2) Average willingness to pay by total 104 consumers for one package of bread, 3) Different superscripts within a column mean significant differences at *P*<0.05

however, demonstrated a different pattern in comparison with those in the blind test. The WTP for Korean wheat flour breads were significantly increased (*P* < 0.01) for all of the Korean wheat flour breads, while the WTP for imported wheat flour breads were slightly decreased from the WTP in the blind test. In previous studies, consumers tended to evaluate more positively the products imported from developed countries than their domestic products (Verlegh and Steenkamp, 1999), and Korean consumers had rated higher consumer acceptance and purchase intent for domestic rice than imported rice (Jang et al., 2012).

**Authors' contributions**

M. J. K. planned the study and wrote the physicochemical analyses part. H. S. K. analyzed the data and wrote the article. H. Y. J. and M. J. L. performed consumer acceptance test and collect data. O. W. K. and H. K. carried out chemical analyses. S. S. K. managed the project and critical revision of the article.

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