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Sensory Properties of Sponge Cake Prepared with Domestic and Imported Cake Flour

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ABSTRACT In this study, consumer acceptance and sensory intensity evaluations were performed on sponge cakes prepared with domestic and imported cake flours. Specific volume data as well as cross-sectional photograph observations confirmed that the imported flour sample group had greater volume than the domestic flour groups. The imported flour sample group also had a significantly (p<0.05) higher mean overall acceptability score at 5.82; however, it was not significantly different from the domestic white flour sample group (5.40). There was no significant difference in overall texture acceptance between samples prepared with imported and domestic white flours; however, their scores were significantly higher than that of the domestic whole flour group (p<0.05). Consumer acceptances of color significantly decreased as the orders of cake group prepared using the imported, domestic white, and domestic whole flours with the values of 6.48, 5.72 and 4.61, respectively (p<0.05). Acceptance of the air cell and the acceptance and intensity of sweetness did not show significant differences between the imported and domestic white flour group.

KEY WORDS: domestic and imported flour, sponge cake, consumer acceptance, intensity

INTRODUCTION

Recently, as peoples' diets have become highly diversified, the consumption of processed wheat flour products has continuously increased (Cheong G 2001, Korea Food Research Institute 1995). In 2006, the annual wheat consumption per person in Korea was 32.4 kg, which was deemed a considerable quantity when compared to the annual rice consumption at 78.8 kg per person (Ministry of Agriculture and Forestry 2007). Korea's self-sufficiency in wheat production, however, is just 0.3%, and most of its demands have been satisfied by imports from the USA, Australia, and Canada. At the same time, health concerns are increasing because not all imported wheat is free of uncontrolled, harmful insecticides and preservatives, which are applied to prevent decomposition. In addition, there is the increasing burden of foreign currency expenditures as a result of imported wheat (Cheong G 2001). As mentioned above, the annual wheat consumption per person in Korea is approximately 32 kg, which is quite similar to that of Japan. However, Japan's self-sufficiency in wheat production is more than 12% whereas Korea's is less than 1%. Accordingly, in the aspect of food security, Korea requires continual government interest and support to improve its domestic wheat production.

Unlike imported wheat, which is seeded in the spring and harvested in autumn, Korean wheat is seeded in the autumn and harvested in spring. Thus, Korean wheat avoids summer, the season in which wheat may be badly damaged by weeds or harmful insects; thus, the use of agricultural chemicals is minimized. Accordingly, soil and water pollution are reduced, and wheat that is photosynthesizing has an air purifying effect by using CO_2 (Choi YB 1997). In recent years, many bakeries have sold increasing amounts of Korean wheat products, in a response to the latest health and wellness trends (Huh K 2006). Although the Korean Wheat Campaign Association was established in November 1991, and areas of wheat cultivation have continuously increased, ongoing efforts to examine species for product development have been considerably insufficient. Furthermore, there are other aspects to consider such as the fact that Korean wheat is relatively expensive as compared to imported wheat (Cheong G 2001, Korea Food Research Institute 1995). Therefore, systematic studies on Korean wheat are

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recommended in order to expand the cultivation of domestic wheat and increase its consumption. There have been some analyses of Korean wheat as well as reports onthe physicochemical characteristics of products prepared using Korean wheat flour, Koh BK 1999, National Crop Experiment Station 2000); some reports have examined baking properties, pasting properties, and cookie-making properties (Chang HG et al 1984, Kim CT et al 1997, Lee SY at al 1997). No studies, however, have examined the consumer acceptance of cakes prepared with Korean wheat flour. Thus, the aim of this study was to examine and compare the properties of cakes prepared with Korean wheat flour to those of cakes prepared with imported flour through quantitative consumer tests.

MATERIALS AND METHODS

Materials

The imported cake flour (Samyang Co., Seoul Korea) and white and whole-grain domestic cake flours (Daehan flour mills Co., LTD., Seoul Korea) used in this study were first grade and purchased from a local market. The imported cake flour was a product of the USA. Sugar (CJ Co.), vanilla powder (Shinjin Foods Co.), eggs, and salt were also used for the cake formulas.

Sponge cake preparation

The cake was prepared according to the standard cake formula AACC mixing method 10-90 (American Association of Cereal. Chemists, 2000) with modifications. Table 1 presents the formulation of the cakes prepared with imported wheat flour, domestic white wheat flour, and domestic whole wheat flour. Eggs were warmed to 30°C in a double boiler and were then mixed with sugar and salt in a mixer (Kitchen-aid, model K5SS, USA) using a wire whip attachment at speed no. 2 for 1 min. The mixing speed was gradually increased to speed no. 10 and then held for 3 min as the sides of the bowl were scraped down with a spatula, which was performed twice. The sifted cake flour and vanilla extract were added and mixed at speed no. 2 for 30 sec. The batter (350 g) was poured into an 8-inch diameter pan, baked at 170°C for 35 min in an electric oven (HSDO 2002, Han Young Bakery Machinery Co., Seoul, Korea), and then cooled at room temperature for 1 hr. Figure 1

Table 1. Sponge cake formula for cakes made with imported and domestic wheat flour

Ingredients	Total (%)	Amount (g)
Flour	100	90
Sugar	120	108
Egg	180	162
Salt	1	0.9
Vanilla powder	0.5	0.45

Whole Egg (180%)

↓ **add sugar (120%) and salt (1%)**

Mixing for 3 min. at speed 10. with Kitchenaid mixer and scraping down for three times

↓ **add cake flour (100%) and vanilla (0.5%)**

Mixing for 30 sec. at speed 2

↓

Panning (350 g)

↓

Baking for 35 min. at 170°C

Fig. 1. Flow diagram of sponge cake preparation.

shows a flow diagram of the cake preparation process.

Specific cake volume

The specific volume of the cake samples was measured using a modified version of the rapeseed replacement method. A small container was filled with rapeseed and transferred to a measuring cylinder to measure the volume of the container (V1). The small container was fully filled with the seeds, which were then placed in a larger container. After putting aside the amount of seed in the small container, a cake sample was placed inside, and the small container was filled with the measured seed until the sample was completely covered and the seed reached the top of the container, which was then leveled by scraping the top. Next, the seed amount in the container with the sample (V2) was measured in a measuring cylinder. The volume of the sample was calculated by the amount of seed in the container without the sample (V1) subtracted by the amount of seed in the container with the sample (V2).

Cross-sectional observations of cake samples

After cooling the cake at room temperature for 1 hr, the center of the cake was cut lengthwise with a slicer (Han young, Seoul Korea) and a picture of the section was taken with a digital camera (Olympus FE-210, Tokyo Japan).

Consumer acceptance test

A total of 70 male and female university students participated as panelists in the consumer acceptance test (Kim HY et al 2004). The attributes of the acceptance test were rated on a 9-increment scale, from “dislike extremely” to “like extremely”. The overall acceptance of attributes was examined in the sequence of overall acceptability, appearance, flavor, and texture. And the acceptance of individual attributes was examined in the sequence of color, air cells, sweetness, lightness, moistness, and softness.

Sensory intensity test

Again, a total of 70 male and female university students participated as panelists in the sensory intensity test. The same attributes of the acceptance test were evaluated for intensity using a 9-increament scale, with responses ranging from “extremely weak” to “extremely strong”.

Statistical analysis

The collected data underwent analysis of variance (ANOVA) using the SAS/STAT (SAS Institute 2001) program. When significant differences were found among the treatments, Duncan's multiple range tests were performed to determine the differences among mean values. Pearson’s correlation analysis was performed between the mean consumer acceptance and intensity scores of the sensory properties.

RESULTS AND DISCUSSION

Cake volume

The cake sample volumes are shown in Table 2. The imported flour sample group had a mean volume of 1,204.67 mL, which was significantly larger than those of the domestic white and whole flour sample groups, with values of 845.33 mL and 854.00 mL, respectively ($p<0.05$).

Cross sectional observations of cake samples

As shown in Figure 2, the cake sample prepared using the imported flour had a fairly even appearance. In contrast, the cake samples prepared using the domestic white and whole wheat flours had slightly concave appearances. As suggested by the volume measurements, the cross-sectional photographs confirmed that the volume of the imported flour sample was larger than those of the cakes prepared with the domestic flours. The cake sample prepared with the imported flour seemed to have more air incorporated into the batter, and the batter also seemed to be more stable until bakingcommenced. Further research, however, is required to prove this factor.

Table 2. Sponge cake volume[1)] using the rapeseed replacement method

Treatment[2)]	Volume (mL)
Imported	1,204.67^{a}
White	845.33^{b}
Whole	854.00^{b}

[1)]Means of three replication. Same letters in a column are not significantly different each other ($p<0.05$)
[2)]Imported, cake prepared with imported cake flour; White, cake prepared with domestic white flour; Whole, cake prepared with domestic whole flour.

Fig. 2. Cross-section photographs of sponge cakes prepared using domestic and imported cake flours. IMPORTED, cake prepared with imported cake flour; WHITE, cake prepared with domestic white flour; WHOLE, cake prepared with domestic whole flour.

Consumer acceptance test

The results of Consumer acceptance test on the cake prepared using the imported, domestic white and whole flours are given in Table 3. The imported flour group had the highest ($p<0.05$) mean overall acceptability value at 5.82; however, it was not significantly different from the domestic white flour group (5.40). The imported flour group also had a significantly higher overall appearance value at 6.24, whereas the domestic whole wheat flour group had the lowest acceptance value at 4.33 ($p<0.05$). The scores for overall flavor acceptance were in the same order as those for overall appearance. The imported and domestic white flour sample groups did not have significantly different overall texture acceptance scores, which were significantly higher than that of the domestic whole wheat flour sample group ($p<0.05$). Consumer acceptances of color significantly decreased as the orders of cake group prepared using the imported, domestic white, and domestic whole flours with the values of 6.48, 5.72 and 4.61, respectively ($p<0.05$). Consumer air cell acceptance was highest in the imported flour group at 5.48, but it was not significantly different from that of the domestic white flour group (5.24) ($p<0.05$). Sweetness acceptance scores were not significantly different between the imported and domestic white flour sample groups, with values of 6.03 and 5.71, respectively, which were higher than that of the domestic whole wheat flour group, showing a value of 4.96 ($p<0.05$). Lightness acceptance scores were not significantly different among the sample groups. The imported flour sample group had a significantly higher mean moistness acceptance score at 6.53 as compared to those of the domestic white and domestic whole wheat flour groups, with values of 5.43 and 5.03, respectively ($p<0.05$). The softness acceptance scores of the groupsshowed a similar pattern to those for moistness acceptance.

Sensory intensity test

The results of sensory intensities on the cake prepared

Table 4. Sensory intensity scores for sponge cakes prepared using domestic and imported cake flours[1)]

Treatment	Imported[2)]	White	Whole
Color	4.89^{a}	4.47^{ab}	4.28^{b}
Air Cell	4.21^{b}	5.10^{a}	4.36^{b}
Sweetness	5.91^{a}	5.40^{a}	4.47^{b}
Lightness	5.37^{a}	4.96^{a}	4.82^{a}
Moistness	4.46^{ab}	4.77^{a}	4.13^{b}
Softness	4.48^{a}	4.33^{ab}	4.13^{b}

[1)]Means of three replication.
Same letters in a column are not significantly different each other ($p<0.05$).
[2)]Imported, cake prepared with imported cake flour; White, cake prepared with domestic white flour; Whole, cake prepared with domestic whole flour.

using the imported, domestic white and whole flours are given in Table 4.

The mean color intensity score of the imported flour group was not significantly different from that of the domestic white flour sample group, with values of 4.89 and 4.47, respectively ($p<0.05$). The color intensity of the domestic white flour group was not significantly different from that of the domestic whole flour group (4.28). Sensory intensities of the air cells in the domestic white flour group had significantly the highest value of 5.10 compared to those of the imported and domestic whole flour group, with values of 4.21 and 4.36, respectively ($p<0.05$). In sweetness, imported and domestic white flour group did not show significant differences with values of 5.91 and 5.40 respectively, however, they were significantly higher than that of whole sample group (4.47) ($p<0.05$). Lightness intensity scores were not significantly different among the sample groups. The moistness intensity scores of the imported flour group were not significantly different than those of the domestic white or domestic whole flour groups. The softness intensity of the imported flour group was not significantly different than that of the domestic white flour group, with values of 4.48 and 4.33, respectively; these values, however, were significantly higher than that of the domestic whole flour group (4.13) ($p<0.05$).

Correlation between acceptance and intensity tests

Table 5 summarizes the Pearson's correlation coefficients for the consumer acceptance and sensory intensity scores of attributes. Color intensity was positively correlated with moistness acceptance ($\gamma=0.99698$, $p<0.05$). There were no significant correlations between air cell intensity and acceptance. For sweetness intensity, overall acceptance ($\gamma=0.99897$, $p<0.05$), overall flavor ($\gamma=0.99901$, $p<0.05$), color acceptance ($\gamma=0.99825$, $p<0.05$), air cell acceptance ($\gamma=0.99986$, $p<0.01$), and sweetness acceptance ($\gamma=0.99813$, $p<0.05$) showed positive correlations. Lightness acceptance and intensity and moistness intensity had no significant correlations. Finally, softness intensity was significantly positively correlated with overall appearance ($\gamma=0.99636$, $p<0.05$), overall flavor ($\gamma=0.99920$, $p<0.05$), color acceptance ($\gamma=0.99968$, $p<0.05$), and air cell acceptance ($\gamma=0.99772$, $p<0.05$).

CONCLUSION

In this study, the quantitative consumer acceptance and sensory intensity scores of sponge cakes prepared with domestic and imported cake flours were examined and their specific volumes were compared. The specific volume of the imported flour group was significantly higher than the volumes of the domestic white and domestic whole flour sample groups. The overall appearance and texture of the imported and domestic white flour sample groups were significantly higher those of the domestic whole flour group. Currently in Korea, the most commonly used wheat flours are made of Australian or American soft wheat. Therefore,

Table 5. Pearson's correlation coefficients for consumer acceptances and sensory intensity scores

		Sensory intensities					
		Color	Air Cell	Sweetness	Lightness	Moistness	Softness
Overall acceptance	Acceptability	0.91041	0.05410	0.99897*	0.88310	0.68443	0.99158
	Appearance	0.97775	-0.16039	0.98561	0.96292	0.51295	0.99636*
	Flavor	0.94389	-0.03583	0.99901*	0.92168	0.61617	0.99920*
	Texture	0.77513	0.30645	0.95454	0.73461	0.84745	0.92596
Individual acceptance	Color	0.94861	-0.05040	0.99825*	0.92724	0.60461	0.99968*
	Air Cell	0.93440	-0.00819	0.99986**	0.91061	0.63770	0.99772*
	Sweetness	0.90376	0.06987	0.99813*	0.87558	0.69587	0.98941
	Lightness	0.83361	0.21117	0.97926	0.79788	0.79102	0.95866
	Moistness	0.99698*	-0.29042	0.95432	0.99028	0.39405	0.97614
	Softness	0.99344	-0.25496	0.96468	0.98447	0.42766	0.98348

*$p<0.05$

in terms of ecological and environmental protection, national health, and food security, consistent efforts must be put forth to extend the cultivation of Korean wheat and improve its consumption. For this to occur, wheat species must be improved, and the characteristics of products made from Korean wheat and imported wheat species must be compared and analyzed systematically and scientifically. If Korean wheat flour products can be diversified and upgraded to offer superior food safety and flavor, a large potential market will be opened.

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