

## Consumer Perception and Sensory Characteristics of Cookies Incorporated with Strawberry Powder

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### Abstract

The effect of baking on the consumer perception and sensory characteristics was investigated using a model system of cookies incorporated with strawberry powder as a value-added food ingredient. Strawberry powder was incorporated into cookie dough at 4 levels (0%, 2%, 4%, and 6%, w/w) by replacing equivalent amount of wheat flour of the cookie dough. After aging and sheeting, cookies were baked at 170°C for 15 min in an oven. The baked cookies were cooled to room temperature for 1 h and packed in airtight bags prior to all measurements. In terms of color, control received the most favorable mean score, which is significantly higher than others ( $p < 0.05$ ) followed by the 4% sample. The consumer preference on taste and aftertaste was not significantly affected by the amount of strawberry powder incorporated in the formulation ( $p > 0.05$ ). Samples with 4% strawberry powder received the highest mean flavor score of 6.28 which is significantly higher than that of 6% sample ( $p < 0.05$ ). In overall, substitution of 4% strawberry powder in the formulation would result in the most favorable strawberry cookies by the consumers with taking advantages of health benefits of strawberry. Correlation analysis indicated that strawberry powder concentration was significantly correlated positively with sensory color and hardness and negatively correlated with consumers' overall acceptability ( $p < 0.05$ ). Consumers' aftertaste was significantly correlated with overall acceptability which was negatively correlated with sensory hardness ( $p < 0.05$ ). Sensory hardness was highly correlated with sensory color attribute ( $p < 0.05$ ).

**Key words:** consumer perception, sensory, cookies, strawberry, powder, correlation

### INTRODUCTION

Consumers' new interests in nutrition and disease prevention demand for value-added foods or functional foods with higher levels of antioxidants (1). Fruits and vegetables contain large amount of antioxidants and increased consumption of them can reduce risks of diseases such as cancer, heart attack, and stroke (2,3).

Strawberries are a good source of bioactive phenolic compounds such as hydroxycinnamic acids, ellagic acid, ellagitannins, flavan-3-ols, flavonoids, and anthocyanins (4). Strawberries contain high antioxidant activity as compared with other fruits (5); 1.3 times the antioxidant activity of oranges, 2 times that of red grapes, 5 times that of apples and bananas, and 13 times that of honeydew melon (6).

Other beneficial effects of strawberries include increased plasma antioxidant capacity in humans (7), antioxidant activity for low density lipoproteins (8), and anti-carcinogenic activity against human and mouse cancer cells (9,10). Strawberry fruit also have high ascorbic acid concentrations which have protective roles against reactive oxygen species (11). As major contributors to the

total phenolic contents, as well as important to fruit color, anthocyanins also have potent antioxidant properties (12) and reduce oxidative stress-induced neurotoxicity (13).

Development of ways to incorporate strawberry fruit as a health food ingredient in human diet and use of the fruit as a value-added food component could provide many health benefits. However, there is limited information on the potential for incorporation of strawberry powder in bakery products such as cookies and its contribution to sensory characteristics and consumer acceptance of the final product. Therefore, the objectives of this research were to evaluate the impact on baking on sensory properties and consumer liking of cookies incorporated with different levels of strawberry powder; and to provide suitable consumer experimental data in developing new types of value-added or functional foods.

### MATERIALS AND METHODS

#### Preparation of raw materials

Lyophilized strawberry powder (Segae FL Co., Ltd., Chungnam, Korea), soft wheat flour (ranked 1st; CJ Corp., Seoul, Korea), granulated sugar (CJ Corp., Incheon,

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Korea), butter (Seoul Milk Coop., Yongin, Gyeonggi, Korea), baking powder (Samjin Foods Co., Ltd., Gyeongbuk, Korea), roasted salt (Daesang Corp., Seoul, Korea), and eggs were procured from a local market and kept at room temperature before use. The strawberry powder was sieved through a laboratory sieve (40 mesh) and a fraction with particles less than 425  $\mu\text{m}$  was used. One hundred grams of the soft wheat flour contained 77 g of carbohydrates, 5 g of protein, 1.5 g of lipids, and 10 mg of sodium.

#### Dough preparation and cookie baking

Ingredients were mixed in a Kitchen Aid mixer (model 5K5SS, Whirlpool Corp., St. Joseph, MI, USA) using a flat beater attachment as described in AACC method 10~52 (14) by incorporating 0~6% (based on the total weight of the soft wheat flour and strawberry powder mixture) of strawberry powder according to the formulation given in Table 1. The dough was aged for 2 hr in a 4°C refrigerator and then sheeted to a thickness of 0.5 cm with the help of a rolling pin. The cookies were cut with a cookie die of diameter 5 cm and transferred to a lightly greased baking tray. The cookies were baked at 170°C for 15 min in a multi-functional convection oven (model GOR-704C, TongYang Magic Corp., Seoul, Korea). The baked cookies were cooled to room temperature for 1 hr and packed in airtight bags prior to measurements.

#### Consumer testing

The consumer test, an acceptance test, was conducted on 50 adults (26 females, 24 males aged between 20 and 26 years). The consumers were informed that the cookies baked with different amount of strawberry powder. All samples were labeled with randomly generated three-digit numbers and four samples were presented in random order. Participants were asked to observe, smell, taste, and consume each sample of cookies. After evaluating each sample, participants judged sample color, taste, flavor, after taste, and overall acceptability

using a structured numeric scale of nine points (9-point hedonic scale), wherein 9=like extremely, 8=like very much, 7=like moderately, 6=like slightly, 5=neither like nor dislike, 4=dislike slightly, 3=dislike moderately, 2=dislike very much, and 1=dislike extremely. Consumers received a tray containing the samples, a glass of water, and an evaluation sheet. Participants were asked to rinse their palates between samples and break for 30 seconds. Enough space was given to handle the samples and the questionnaire, and the evaluation time was not constrained.

#### Sensory analysis

A panel of 8 assessors (4 females, 4 males aged between 20 and 24 years) were selected, screened and recruited among the students from the Department of Food Science and Engineering at Daegu University (Gyeongbuk, Korea). The assessors were screened by conducting 10 sets of triangle tests discriminating taste between samples containing 2 or 4% strawberry powder under red fluorescent light. Those who correctly answered more than 60% of the tests were first selected as potential panelist for further training.

On each day, assessors received a total of four samples and a 2 min interval was allowed between each sample to reduce the likelihood of carryover. Each assessor was provided with water and asked to cleanse their palate between testings. Sample attributes were scored on 9-point category scales, wherein 9=extremely strong, 8=very much strong, 7=moderately strong, 6=slightly strong, 5=neither strong nor weak, 4=slightly weak, 3=moderately weak, 2=very much weak, and 1=extremely weak. Flavor and hardness were evaluated under red fluorescent light while color was done under regular fluorescent light.

#### Statistical analysis

The statistical analysis was done using the SAS Statistical Analysis System for Windows v9.1 (SAS Inst. Inc., Cary, NC, USA). The means were compared with Duncan's multiple range test at 5% level of significance.

## RESULTS AND DISCUSSION

A 9-point hedonic scale was used to determine which cookies incorporated with different levels of strawberry powder were preferred by the majority of consumers. Table 2 shows the mean scores of consumer sensory results on the several attributes including color, taste, flavor, after taste, and overall acceptability whilst Fig. 1 presents the spider charts on each attribute, respectively. In terms of color, control sample received the most favorable mean score of 6.46, which is significantly higher than others ( $p < 0.05$ ) followed by 4% sample. On the

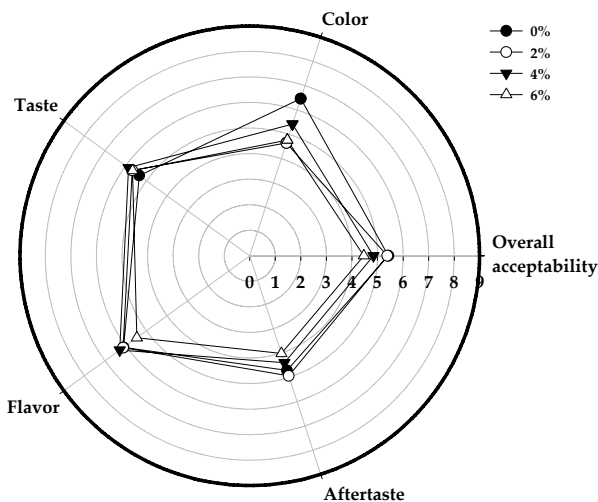
**Table 1.** Formulation of cookies on substitution of strawberry powder for soft wheat flour

Ingredients (g)	Sample			
	0%	2%	4%	6%
Soft wheat flour	100	98	96	94
Strawberry powder	0	2	4	6
Granulated sugar	55	55	55	55
Butter	35	35	35	35
Baking powder	0.5	0.5	0.5	0.5
Salt	1	1	1	1
Egg	20	20	20	20
Total	211.5	211.5	211.5	211.5

**Table 2.** Mean scores of consumer acceptance results (9-point hedonic scale) for cookies incorporated with different levels of strawberry powder

Sample	Consumer attributes				
	Color	Taste	Aftertaste	Flavor	Overall acceptability
0% (Control)	6.46 <sup>a</sup>	5.34 <sup>a</sup>	4.72 <sup>a</sup>	6.10 <sup>ab</sup>	5.42 <sup>a</sup>
2% Strawberry powder	4.64 <sup>c</sup>	5.68 <sup>a</sup>	4.94 <sup>a</sup>	6.12 <sup>ab</sup>	5.38 <sup>a</sup>
4% Strawberry powder	5.42 <sup>b</sup>	5.86 <sup>a</sup>	4.40 <sup>a</sup>	6.28 <sup>a</sup>	4.84 <sup>ab</sup>
6% Strawberry powder	4.76 <sup>bc</sup>	5.66 <sup>a</sup>	4.02 <sup>a</sup>	5.46 <sup>b</sup>	4.46 <sup>b</sup>

<sup>a-c</sup>Different letters within the same column indicate significant difference ( $p < 0.05$ ).

**Fig. 1.** Consumer acceptance profiles of cookies incorporated with different levels of strawberry powder.

other hand, 2% sample received the lowest mean score with respect to color among all samples tested. Kim (15) reported similar findings that yellow layer cakes without strawberry powder (control) received significantly higher mean acceptability scores in terms of the crust color as well as crumb color. It is probably due to the fact that natural red color of strawberry powder becomes dark during baking; anthocyanin pigments degrade due to the heat, which in turn reduce the color acceptability (15).

The consumer preference on taste was not significantly affected by the amount of strawberry powder incorporated in the sample. The scores of taste acceptability varied from 5.34 to 5.86, and they were not significantly different each other ( $p > 0.05$ ). This also indicates that all samples were considered as somewhere between "neither like nor dislike" and "like slightly". It is noted that cookies with strawberry powder regardless of the concentration received the higher scores of taste acceptability than that of the control (cookies without strawberry powder). Similar result was reported when cookies were made with onion powder (16). In addition, the strawberry powder incorporated in the cookies was not a strong factor to influence the consumer preference on aftertaste as similar to taste. Kim (15) also noted no

significant differences in terms of taste acceptability among yellow layer cakes containing 1~4% of strawberry powder.

The mean scores of flavor acceptability ranged from 5.46 to 6.28. Samples with 6% strawberry powder received the lowest mean score which is significantly lower than that of 4% sample ( $p < 0.05$ ). There were no significant differences found among control, 2%, and 4% samples in terms of consumer flavor acceptability ( $p > 0.05$ ). It is also noted that the consumers appeared to accept the strawberry flavor when consuming the cookies unless it is too strong.

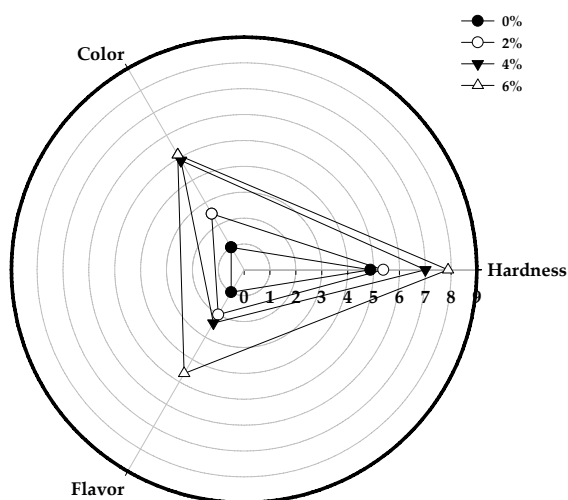
With respect to overall acceptability, control samples received the highest mean score of 5.42; however, it is not significantly different from that of 2% and 4% sample ( $p > 0.05$ ). Six percent samples received the lowest mean score of 4.46, significantly different each other with that of control and 2% sample ( $p < 0.05$ ). It is noted that incorporation of strawberry powder up to 4% in the formulation of cookies did not significantly influence the consumers' acceptability in all attributes tested except for color. Therefore, incorporation of 4% strawberry powder in the formulation of cookies would be recommended while taking advantages of health benefits of strawberry fruit without sacrificing the color acceptance by the consumers.

The results of the sensory analysis are presented in Table 3 and Fig. 2. Intensity scores for cookies showed that sensory color, flavor, and hardness attributes were significantly affected by different levels of strawberry powder incorporated in the formulation of cookies.

**Table 3.** Mean scores of sensory intensity results (9-point intensity scale) for cookies incorporated with different levels of strawberry powder

Sample	Sensory attributes		
	Color	Flavor	Hardness
0% (Control)	1.000 <sup>c</sup>	1.000 <sup>c</sup>	4.875 <sup>c</sup>
2% Strawberry powder	2.500 <sup>b</sup>	2.000 <sup>b</sup>	5.375 <sup>c</sup>
4% Strawberry powder	4.875 <sup>a</sup>	2.375 <sup>b</sup>	7.000 <sup>b</sup>
6% Strawberry powder	5.125 <sup>a</sup>	4.625 <sup>a</sup>	7.875 <sup>a</sup>

<sup>a-c</sup>Different letters within the same column indicate significant difference ( $p < 0.05$ ).



**Fig. 2.** Sensory intensity profiles of cookies incorporated with different levels of strawberry powder.

Increases in strawberry powder concentration up to 6% in the cookie formulation significantly increased the intensities of sensory color, flavor, and hardness attributes ( $p < 0.05$ ).

The correlation among all consumer attributes and sensory attributes for cookies incorporated with different levels of strawberry powder is given in Table 4. All bolded values in Table 4 are significant correlations at  $p < 0.05$ . Consumers' overall acceptability attribute has a significant negative correlation to strawberry concentration and a significant positive correlation to aftertaste ( $p < 0.05$ ). Color and hardness sensory attributes have a significant positive correlation to strawberry concentration while hardness sensory attribute has a significant negative correlation to overall acceptability ( $p < 0.05$ ). Finally, hardness sensory attribute is significantly correlated with sensory color positively ( $p < 0.05$ ). Color, taste, and flavor consumer attributes and flavor sensory attribute had no correlation to any of the attributes measured.

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**Table 4.** Correlation between all consumer attributes and sensory attributes for cookies incorporated with different levels of strawberry powder where bolded values are significant at  $p < 0.05$

		Strawberry concentration		Consumer attributes				Sensory attributes	
		Color	Taste	Flavor	Aftertaste	Overall acceptability	Color	Flavor	
Consumer attributes	Color	-0.669							
	Taste	0.681	-0.663						
	Flavor	-0.627	0.400	0.108					
	Aftertaste	-0.851	0.210	-0.306	0.705				
	Overall acceptability	<b>-0.959</b>	0.440	-0.523	0.670	<b>0.964</b>			
Sensory attributes	Color	<b>0.963</b>	-0.595	0.813	-0.404	-0.799	-0.922		
	Flavor	0.949	-0.672	0.448	-0.837	-0.847	-0.921	0.830	
	Hardness	<b>0.982</b>	-0.517	0.635	-0.598	-0.921	<b>-0.990</b>	<b>0.966</b>	0.913

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