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Quality Characteristics of Sponge Cake added with *Citrus peel* Powder

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ABSTRACT: This study was conducted to evaluate the effect of *Citrus peel* powder on the quality characteristics of sponge cake. *Citrus peel* powder sponge cake was prepared with different ration of *Citrus peel* powder(0, 10, 20, 30, 40%). The specific gravity, baking loss rate and cake weight increases as the ratio of *Citrus peel* powder. The sponge cake's a, b level increased with the increasing level of *Citrus peel* powder 40% appeared to be the highest. In terms of textural characteristics, the samples containing 10, 20, and 40% *Citrus peel* powder had significantly higher hardness than the control samples. The substance's level of springiness, and cohesiveness decreased as the *Citrus peel* powder additive increased. In sensory evaluation, overall acceptability and taste of the cake was better than others when 10% *Citrus peel* powder was added. The results indicated that substituting 10% *Citrus peel* powder to sponge cake is optimal for quality and provides a product with reasonable high overall acceptability.

Keywords: *Citrus peel* powder, sponge cakes, characteristics, sensory evaluation

INTRODUCTION

The Citrus, which is a family of Ructaaceac and Aurantioideae, but closely related to Fortunella, and Pocirus, is called “Citrus unshiu M” or “Citrus mandarin” and only the genus citrus are raised as a fruit tree. (Chung SK et al 2000). The Citrus is used as a ingredient of functional foods that has not only anti-allergic, anti-inflammatory, but also anti-virus and antitumor effect as well. In addition, it cleans blood vessels by reducing LDL cholesterol in the blood. It is also used as medicinal herbs because Hesperidin(ie. a flavanone glycoside found in citrus fruits) aids capillary contraction which leads to hypertension prevention(Shin JP et al 1999).

There are research says “Pork Sausage with Added *Citrus peel* and Dried *Lentinus edodes* Powders” (Kang YJ et al 2005), “Growth Performance, Hematological Parameter and Fatty Acid Composition of Growing Olive Flounder to Dietary Inclusion of Citrus Meal”(Seo JY et al 2010), “Effects of Feeding Diets Containiing Tangerine Pulp, Sea Tangle or Prickly Pear Cactus on Lipid Level, Intestinal Cholesterol Absorption, Platelet Aggregation and Liver Tissue in Hypercholestrolemic Rats” (Kang MS 2011), “Muffin added with Tangerine Peel Powder”(OH SW 2014), “*Injeulmi* Containing Different Ratios of Citrus Mandarin Powder (Kim CW 2009), “Pound Cake with Citrus Mandarin Powder” (Park YS et al 2008), “Post-Daged *Doenjang* (Fermented Soybean Pastes) added with Citrus Fruits, Green Tea and Cactus Powder” (Kim JH et al 2010), “*Yanggaeng* added with Freeze dried Citrus Mandarin Powder” (Cha MA 2013), “Pan Bread Added with Citrus Mandarin Peel Powder” (Lee EJ et al 2012) Sponge cake is a cake based on flour, sugar, and eggs. Combining flour that contains

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captured air and foam made of sugar and eggs is a simple process of making sponge cake. There are largely two ways to make sponge cake : hot sponge mix, cold sponge mix. Hot sponge mix is a way to make dough with foam made of a whole egg. Recently, adding new ingredients in sponge cake has become cake has become a trend due to an interest and demand on functional foods. Concerning that there are studies like "Rice Sponge Cakes Containing Various Levels of Jerusalem Artichoke Powder"(Suh KH 2014), "Spinach Powder" (Lee UN et al 2014), "Sponge Cake Added with *Laminaria japonia* Powder" (Lee UN et al 2013), "Sponge Cake Containing *Beaknyuncho*(*Opuntia ficus-indica* var. *saboten*) Powder"(Lee SB 2013), "Sponge Cakes Supplemented with Cinnamon"(Lee SB 2013), "Sponge Cake with *Pakchoi*(*Brassica compestris* L. ssp. *chinensis* Jusl.) Powder"(Chung YS 2009), "Sponge Cakes with Addition of *Gastrodiae rhizoma* Powder" (Kang CS 2007), "Sponge Cake Containing Varying Amounts of Persimmon Leaf Powder"(Chio GY et al 2007), we conclude tangerine peel powder can be also used on sponge cake products. Therefore, in this study we will make a sponge cake with tangerine peel powder by adding different ratio of the powder; 10, 20, 30, 40%. Then we will measure its general component, specific gravity, pH, weight, volume, loss ratio when baking, chromaticity, texture, and sensory test to decide the optimum compounding ratio of the tangerine peel powder added sponge cake.

MATERIALS

The materials used in the study were as follows : *Citrus peel* powder(Chinese medicine Store, Seoul, Korea), weak flour(KFMC Co., Dangjin, Korea) milled from American soft flour, eggs and sugar(Samyang, Co., Incheon, Korea), refined salt, water.

Material Mixing Ratio of Sponge Cake

The material ratio of the sponge cake used in this experiment is as follows in Table 1. *Citrus peel* powder were added at the level of flour 0%(Control), 10%(CPP10), 20%(CPP20), 30%(CPP30), 40%(CPP40). The material ratio of *Citrus peel* powder and wheat flour was set through several preliminary experiments. The sponge cake prepared without *Citrus peel* powder was designated as control group. The sponge cake with added *Citrus peel* powder by rate of 10, 20 30, 40% was designated as test group. The other material ratio of sponge cake except for wheat flour and *Citrus peel* powder were the same as in the control group.

Preparation of a Sponge Cake with the Addition of Citrus peel Powder

Method of producing a sponge cake with the addition of *Citrus peel* powder was prepared by the hot sponge method which is the most common method on the shop floor. First, the eggs, sugar and salt was put into a stainless bowl, cooked in a double boiler

Table 1. Standard formula for sponge cakes with *Citrus peel* powder(g)

Ingredients	Control[1)]	CPP 10%[2)]	CPP 20%[3)]	CPP 30%[4)]	CPP 40%[5)]
Flour	400	380	360	340	320
Whole egg	400	400	400	400	400
Sugar	400	400	400	400	400
Water	16	14	16	16	16
Citrus peel powder	0	20	40	60	80

[1)] Control: Flour powder 100%.
[2)] CPP 10%: *Citrus peel* powder 10% added.
[3)] CPP 20%: *Citrus peel* powder 20% added.
[4)] CPP 30%: *Citrus peel* powder 30% added.
[5)] CPP 40%: *Citrus peel* powder 40% added.

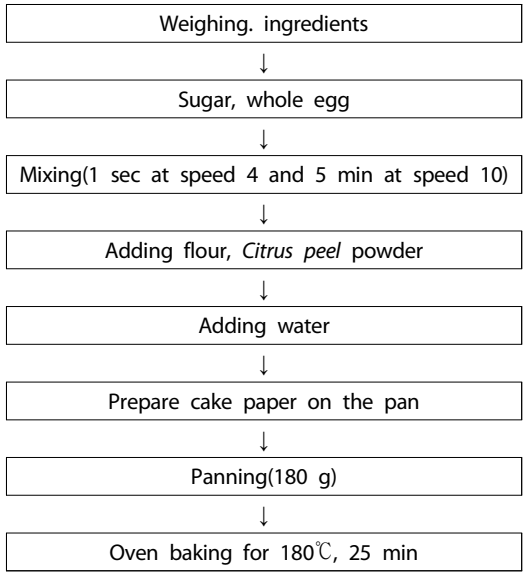

Figure 1. Diagram for making sponge cake containing *Citrus peel* powder.

at 45℃ and then, mixed with a Kenwoob mixer(Co., London., United Kingdom) for 30seconds at dial 1, for 5 minutes at dial 4, for 5 minutes at dial 10 in sequence. The batter crust around mixing bowl was scraped out with a rubber spatula. Then, the batter mixture were further mixed for 30 seconds at dial 1. After that, water was added to the batter mixture, mixed well to the floor. Next, 180 g of the cake batter was placed into No. 1 fan. The cakes were then transferred to a lightly greased baking tray and baked in an electric oven (Dae Yung Bakery, Machinery Co., Seoul) at upper temperature of 180℃ and lower temperature of 180℃ for 25 min. The baked cakes were removed from the baking pan, allowed to cool at room temperature for 1 hr before anaysis.

The Specific Gravity and pH of the Sponge Cake Batter with Added Citrus peel Powder

The specific gravity of the sponge cake batter with added *Citrus peel* powder was calculated using the equation below according to the AACC method 10-15(11)

$$Specific\ Gravity(\%) = \frac{W_{cup\ containing\ water} - W_{cup}}{W_{cup\ containing\ batter} - W_{empty\ cup}} \times 100$$

10 grams of cake batter and 45 mL of distilled water were mixed completely and the pH was measured 3 times using a pH meter (ORION Co., Ltd., California, USA) as described in the (Choi et al 2000).

Measurement of Height, Weight, Dough Yield and Baking Loss

The height of sponge cake was measured from 5 different points after cutting into pieces using template according to AACC 10-15(1986). The weight of sponge cake was measured with scale. The dough yield and baking loss were calculated with following equation.

$$Water\ Holding\ Capacity(\%) = \frac{W_{batter\ before\ baking}}{W_{cake\ after\ baking}} \times 100$$

$$Baking\ Loss(\%) = \frac{W_{batter} - W_{cake}}{W_{batter}} \times 100$$

Measurement of Volume and Specific Volume

The volume of sponge cake prepared with different ration of *Citrus peel* powder was measured by the method of seed substitution. The Specific volume was calculated with following equation.

$$Specific\ Volume(mL/g) = \frac{V_{Sponge\ cake}}{W_{Spongecake}} \times 100$$

Physicochemical Measurements of Sponge Cakes

The chromaticity of sponge cake ((20×20×20 mm) was measured using a color m meter (CE-7000, Macbeth Spectrophotometer, New York, USA) calibrated with a white tile(Calibration palate CR-A43, L=95.91, a=0.00, b=2.27), and expressed as Hunter's L(lightness) a(redness) and b(yellowness) color values. The textural properties of cake (40×40×30 mm) were measured using a Rheometer(Sun Scientific Co., Ltd., Tokyo, Japan). Operating conditions were as follows: load cell: 2 kg, adaptor type: circle(diameter 20 mm), table speed: 60 mm/min.

Sensory Evaluation

A panel of 20 assessors were selected from the students in the Department of Culinary Science at Gwangju University(Jeonnam, Korea). All assessors had been trained to get a taste of samples and acquainted with the method and properties of evaluation. The assesors evaluated the appearance, color (internal and external), flavor, taste, texture, and overall acceptability(the level of preference from the customer''s viewpoint) on a 5 point Likert scales. All samples were presented to the size of 3×3×1 cm labeled with three-digit numbers in the white plate using a table of sampling digits. Evaluation items were color, appearance, flavor, taste, texture and overall acceptability.

Statistical Analysis

One-way analysis of variance (ANOVA) and Duncan''smultiple range test were performed for significant differences. The *p*-values less than 0.05 were considered statistically significant. One-way ANOVA, Pearson''s correlation, and simple linear regression analyses were conducted using SPSS(SPSS 12.0 for windows, SPSS Inc., Chicago, IL, USA).

RESULT

Specific Gravity and pH

Table 2 shows the Specific gravity and pH of the sponge cake batter with added *Citrus peel* powder. High specific gravity makes a compact and small volume pole. In contrast, low specific gravity makes rigid internal injuries due to the lack of entrained air. Specific gravity is influnced by the type of wheat flour, temperature, time and mixing conditions, mixing speed, existence and type of chemical leavening agent. The Specific gravity value of control group was 0.50 and gradually decreased as the added *Citrus peel* powder increased, ranging from 0.46 to 0.48 in 10～40% sample groups. Similar result was reported for the sponge cake with added black garlic(Uoo YY et al 2006), rice cupcake prepared with pine leaf powder(Kim WJ et al 2012). In terms of pH value, control group was measured to most lowest value of 6.83 and gradually increased as the added pine leaf powder increased, ranging from 4.90 to 6.24 in 10～40% sample groups. Other food conclude ingredient such as oil-and-honey-pastry(Park BH et al 2012) caused similar increase in the pH value of sponge cake.

Table 2. Specific gravity and pH added *Citrus peel* powder

Samples	Specific gravity	pH
Control	0.50±0.02$^{a)1)}$	6.83±0.26$^{a1)}$
CPP 10%$^{2)}$	0.48±0.01^{ab}	6.24±0.03^{b}
CPP 20%	0.48±0.01^{ab}	5.66±0.07^{c}
CPP 30%	0.47±0.00^{b}	5.16±0.08^{d}
CPP 40%	0.46±0.01^{b}	4.90±0.03^{e}

1) Values are mean±standard deviation(n+3).
2) Means with the same superscripts in the row are significantly different (p<0.05).
3) CPP : *Citrus peel* powder.

Cake Weight, Dough Yield and Baking Loss Added Citrus peel Powder

The weight of sponge cake batter with different ration of *Citrus peel* powder(0, 10, 20, 30, 40%) before/after baking, dough yield and baking loss is as follows in Table 3. There was no significant difference in the weight of sponge cake batter among all samples. However, after baking, the control was measured to lowest value of 305.3 and those of 10～

Table 3. Cake weight, dough yield and baking loss added *Citrus peel* powder

Samples	Cake weight(g)	Dough yield rate(%)	Baking loss rate(%)
Control	305.33±1.13$^{a)1)}$	132.45±0.03^{a}	7.68±0.01$^{1)a}$
CPP 10%$^{2)}$	305.00±1.00^{a}	133.33±0.33^{a}	7.58±0.01^{b}
CPP 20%	306.00±0.00^{a}	132.70±0.58^{ab}	7.27±0.01^{c}
CPP 30%	306.67±2.08^{a}	132.89±0.90^{b}	7.07±0.01^{d}
CPP 40%	307.33±2.31^{a}	132.45±0.33^{a}	6.86±0.01^{e}

1) Values are mean±standard deviation(n+3).
2) Means with the same superscripts in the row are significantly different (p<0.05).
3) CPP : *Citrus peel* powder.

40% samples ranged from 305.0 to 307.3. As the amount incorporated into the formulaation increased, the weight of sponge cake significantly decreased(p<0.001). Similar decrease was observed for the sponge cake prepared with roasted black bean powder(Jung, 2012). The dough yield of sponge cake in control group was 131.0% and gradually increased as the amount incorporated into the formulation increased, ranging 130.1% to 131.1% in 10 ~40% sample groups.

This result is considered to be due to the difference between the weight of the samples. It was also reported baking loss is resulted from the dough puffed by the heat and water evaporation in the pores of the dough during baking process. In terms of baking loss, the control was 7.68% and tended to decrease as the pine leaf powder content increased, ranging from 6.86% to 7.58% in 10~40% sample groups. Similar result was found for sponge cake made with made with Ecklonia cava powder(Lee & Heo, 2010), pine leaf powder sponge cake(Lee & Lee, 2013).

Cake Height, Volume and Specific Volume Added Citrus peel Powder

Table 4 shows cake was measured from 5 different point after cutting into pieces using template. according to AACC(2000)10-15. The height value of sponge cake was highest for control group with 6.88 cm and tended to decreased as *Citrus peel* powder content increased, ranging from 4.70 cm to 6.38 cm in 10~40% sample groups. Similar result was found for sponge cake made with pakchoi powder(Chung & Kim, 2009). Volume and specific volume added *Citrus peel* powder were measured with the method of seed substitution. The volume was highest for the control cake with 708.00 cm^3 and those of samples ranged from 491.33 to 643.33 cm^3. As *Citrus peel* powder content increased, the volume tended to decreased significantly(Kim et al 2012). In terms of specific volume, the value of control cake was observed to 2.32 cm^3/g and those of 10~40% sample groups ranged from 1.60 cm^3/g to 2.11 cm^3/ g. This indicates that the control cake had the highest specific volume, which decreased in proportion to the level of *Citrus peel* powder(p<0.001).

It showed same result as the volume, which is considered to be due to reduced flour content depending on increased amount of added *Citrus peel* powder. A similar finding was reported for the sponge cake made with lotus leaf and lotus root powder(Kim et al 2011).

Table 4. Cake hight, volume and specific volume added *Citrus peel* powder

Samples	Cake hight(cm)	Volume(cm^3)	Specific volume(cm^3/g)
Control	6.88±0.01[a)1)]	708.00±7.21[a]	2.32±0.00[a]
CPP 10%[2)]	6.38±0.01[a]	643.33±8.08[b]	2.11±0.01[b]
CPP 20%	5.84±0.02[a]	622.67±18.47[c]	2.03±0.01[c]
CPP 30%	5.24±0.05[a]	586.67±5.03[d]	1.91±0.01[d]
CPP 40%	4.70±0.01[a]	491.33±11.10[e]	1.60±0.01[e]

[1)] Values are mean±standard deviation(n+3).
[2)] Means with the same superscripts in the row are significantly different (p<0.05).
[3)] CPP : *Citrus peel* powder.

Color Evaluation

The L(lightness) value of the sponge cake incorporated with different levels of *Citrus peel* powder was shown in Table 5. The L value of the control cake was observed to 46.43 and those of sample groups ranged from 29.31 to 39.17. This indicates that the control cake had the highest brightness, which decrease in proportion to the level of the

Table 5. Hunter's color value of sponge cake added *Citrus peel* powder

Samples	L	a	b
Control	46.43±0.01[a)1)]	10.62±0.06[a]	31.03±0.60[b]
CPP 10%[2)]	39.17±0.23[a]	13.98±0.33[b]	27.51±0.66[b]
CPP 20%	37.94±0.06[b]	13.59±0.33[a]	27.81±0.30[a]
CPP 30%	31.85±0.00[a]	12.25±0.01[a]	21.64±0.01[a]
CPP 40%	29.31±0.66[c]	8.45±0.00[a]	18.08±1.02[c]

[1)] Values are mean±standard deviation(n+3).
[2)] Means with the same superscripts in the row are significantly different (p<0.05).
[3)] CPP : *Citrus peel* powder.

Citrus peel powder(p<0.001). Similar decreases in *L* are caused by the incorporation of other food ingredient powders such as laver(Keeon et al 2005) and paprica(Jeong et al 2007).

Hunter a value (redness) of the control cake was 10.62 and gradually increased as the added pine leaf powder increased, resulting in the highest value of 18.45 for the cake containing 40% *Citrus peel* powder. Hunter b value(yellowness) of the control cake was the highest with 31.68 and decreased with the increasing level of the *Citrus peel* powder, showing the value of 27.52～18.08 in 10～40% samples(p< 0.001).

In a parallel study with red Ginseng powder, as the amount incorporated into the formulation increased, b value decreased significantly. These result, the significant difference of L, a, b value between control group and *Citrus peel* powder added groups are considered to be attributable to the own color the *Citrus peel* powder have itself. Formulation of the *Citrus peel* powder with other food such as noodle(Jeon et al 2005) and matrimony vine(Kim & Shin, 2005) caused similar result. As the amount incorporated into the formulation increased, *L* decreased while *b* increased significantly. Therefore, it could be stated that The L(lightness) value of the sponge cake was affected by the incoporation of *Citrus peel* powder.

Texture Analysis

Previously reported, subsidiary ingredients affect the texture properties of sponge cake, and thus the textural characteristics of sponge cake with different ration of *Citrus peel* powder(0, 10, 20, 30, 40%). were determined as follows in Table 6. The hardness of the 10～40% samples group ranged 1,641.22 to 4,106.21 was significantly higher than the control measured to 650.56 (g/cm^2). In fact, the hardness value was significantly increased as the amount of *Citrus peel* powder incorporated in the formulation increased. The hardness of the sponge cake was affected by moisture content of the cake, degree of pore development and volume. It was considered to be due to added *Citrus peel* powder which interfered with bubble foaming, so that the batter was obstructed to make the film of the bubble, resulting in the compact structure inside the cake.

Table 6. Texture properties of sponge cake added *Citrus peel* powder

Sample	Hardness (g/cm^2)	Springiness (%)	Cohesiveness (%)
Control	650.56±1.48$^{a)1)}$	0.85.±0.16^a	0.44±0.04^a
CPP 10%$^{2)}$	1,641.22±2.25^c	0.80±0.08^a	0.43±0.01^a
CPP 20%	1,839.69±2.20^a	0.80±0.09^a	0.45±0.03^a
CPP 30%	2,108.93±1.36^a	0.78±0.03^a	0.43±0.08^a
CPP 40%	4,105.21±2.13^b	0.76±0.04^a	0.43±0.11^a

1) Values are mean± standard deviation(n+3).
2) Means with the same superscripts in the row are significantly different (p<0.05).
3) CPP : *Citrus peel* powder.

Similar result was found for the sausage with added *Citrus peel* powder(Kwon et al 2012) and sponge cake with added *Cudrania tricuspidata* leaf powder(Lee et al 2013). The springiness value was highest for control group with 0.85 and significantly decreased, from 0.76 to 0.80 as added the *Citrus peel* powder increased in the formulation. The cohesiveness value of control group was highest with 0.44 and gradually decreased with increasing the level of *Citrus peel* powder, showing the value of 0.43～0.45 in 10～40% sample groups(p<0.001). The sponge cake with added pumpkin puree(Park et al 2008) and sponge cake with added artichoke powder(Suh & Kim, 2014) also caused similar decrease in the cohesiveness of sponge cakes.

Sensory Analysis

A 9-point hedonic scale was used to determine which sponge cake incorporated with different levels of *Citrus peel* powder were preferred by the majority of consumers. Table 7 shows the mean scores of consumer sensory results on the several attributes including appearance, taste, flavor, texture and overall acceptability. In terms of appearance, the control received the most favorable mean scores of 4.07 and 10～40% sample ranged from 3.79 to 4.68 In fact, the appearance acceptance decreased as the percent of pine leaf powder incorporation increased in the formulation.

Table 7. Sensory properties of sponge cake added *Citrus peel* powder

Samples	Appearance	Flavor	Taste	Texture	Overall acceptability
Control	4.07±1.30$^{bc)1)}$	3.80±0.95^{b}	4.18±1.18^{a}	3.26±1.13^{a}	4.38±1.26^{a}
CPP 10%$^{2)}$	4.68±1.13^{ab}	4.23±1.23^{ab}	4.50±1.00^{a}	4.13±1.065^{a}	4.50±0.95^{a}
CPP 20%	4.86±1.27^{a}	4.77±0.85^{a}	4.36±1.03^{a}	4.24±0.92^{a}	4.28±0.93^{b}
CPP 30%	3.78±1.27^{c}	4.29±0.10^{ab}	4.42±1.04^{a}	4.27±0.96^{a}	4.09±1.03^{ab}
CPP 40%	3.78±0.93^{c}	3.87±0.82^{b}	3.82±1.14^{a}	4.05±1.08^{a}	3.61±1.09^{b}

[1] Values are mean±standard deviation(n+3).

[2] Means with the same superscripts in the row are significantly different (p<0.05).

[3] CPP : *Citrus peel* powder.

The consumer preferences on flavor were significantly affected by the amount of *Citrus peel* powder incorporated in the sample. In the acceptability of flavor, the control received 3.8 and 10～40% sample ranged 3.8 to 4.2 This result is consistent with the study of the rice cake with added pine leaf(Lee & Han, 2002) and cookie with added pine leaf powder(Jung et al 2009). In terms of taste, the control received the most favorable mean scores of 4.1 and 10～40% sample received relatively low scores ranged 3.8 to 4.5. There were significant differences found among the samples(p<0.001). In terms of texture, the control received 4.18 and 10～40% sample ranged from 3.8 to 4.5. In fact, as the amount incorporated into the formulation increased, the texture acceptance tend to decreased. Overall acceptability was the highest in control group with 4.3 and tended to decreased, from 3.6 to 4.5, with the increasing level of *Citrus peel* powder. Similar result was found for the study on uniformity and moisture of pore(Shin 2007), the importance of the cake with suitable volume, uniform organization, soft feel(Mizukoshi 1983) and cookie made with matrimony vine(Park et al 2005). Therefore, The results indicated that substituting 10% *Citrus peel* powder to sponge cake is optimal for quality and provides a product with reasonable high overall acceptability.

RESULT AND DISCUSSION

The Specific gravity value of control group was 0.50 and gradually decreased as the added *Citrus peel* powder increased, ranging from 0.46 to 0.48 in 10～40% sample groups. In terms of pH value, control group was measured to most lowest value of 6.83 and gradually increased as the added pine leaf powder increased, ranging from 4.90 to 6.24 in 10～40% sample groups. After baking, the control was measured to lowest value of 305.3 and those of 10～40% samples ranged from 305.0 to 307.3. The dough yield of sponge cake in control group was 131.0% and gradually increased as the amount incorporated into the formulation increased, ranging 130.1% to 131.1% in 10～40% sample groups. In terms of baking loss, the control was 7.68% and tended to decrease as the *Citrus peel* powder content increased, ranging from 6.86% to 7.58% in 10～40% sample groups. The height value of sponge cake was highest for control group with 6.88 cm and tended to decreased as *Citrus peel* powder content increased, ranging from 4.70 cm to 6.38 cm in 10～40% sample groups. In terms of baking loss, the control was 7.68% and tended to decrease as the *Citrus peel* powder content increased, ranging from 6.86% to 7.58% in 10～40% sample groups. The height value of sponge cake was highest for control group with 6.88 cm and tended to decreased as *Citrus peel* powder content increased, ranging from 4.70 cm to 6.38 cm in 10～40% sample groups.

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감귤분말을 첨가한 스펀지 케이크의 품질특성

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국문초록

본 연구는 감귤과피 분말을 10, 20, 30, 40%로 첨가하여 스펀지케이크의 반죽의 비중, pH, 부피, 무게, 색도, 조직감을 측정하고, 관능검사를 실시하였다. 스펀지케이크의 비중과 무게는 대조군의 비중은 0.50, pH는 6.83로 10~40% 첨가군까지 유의적으로 감소하였다. 무게는 대조군이 305.3 g으로 가장 낮게 나타났으며, 10~40% 첨가군은 유의적으로 증가하였다. 케이크의 높이는 대조군이 6.88 cm, 부피는 708.00 mL, 비용적은 2.32 cm^3/g으로 가장 높게 나타났으며, 10~40% 첨가군은 유의적으로 감소하는 차이를 나타났다. 감귤과피 분말을 첨가한 케이크의 색도 L(명도)은 대조군이 46.43으로 가장 높게 나타났으며, 40% 첨가군이 29.31로 가장 낮게 나타냈다. b(황색도)는 대조군이 31.03으로 가장 높게 나타났으며, 40% 첨가군이 18.03으로 가장 높은 값을 나타냈다. 감귤과피 분말 첨가량이 증가할수록 a, b값은 유의적으로 감소하게 나타났다. 조직감의 측정결과로 탄력성(springiness), 응집성(cohesiveness)은 대조군이 높게 나타났으며, 감귤과피 분말의 첨가량이 증가할수록 감소하는 경향을 보였다. 관능검사에서는 맛(taste), 종합적인기호도(overall acceptability)에서 감귤과피 분말 10% 첨가군이 가장 우수하게 나타났다. 이와 같이 본 실험을 통하여 감귤과피 분말 10%를 첨가하면 건강 지향적인 측면을 고려한 스펀지케이크 상품으로 개발이 가능한 적절한 배합비로 사료되었다.

주제어: 감귤 분말, 스펀지케이크, 특성, 관능검사