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Quality Characteristics of Sponge Cake added with Pine Leaf Powder

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ABSTRACT: This study investigated the quality characteristics of sponge cake added with pine leaf powder. The pine leaf powder sponge cake was prepared with different ration of pine leaf powder(0, 10, 20, 30, 40%). The specific gravity, baking loss rate and cake weight increased significantly with increasing the levels of pine leaf powder. In terms of color, lightness and yellowness increased with increasing levels of pine leaf powder. The sponge cake added with ratio of 40% pine leaf powder appeared to be the highest. In terms of textual property evaluation, sponge cake were increased by the level of pine leaf powder. The substance's level of springiness, and cohesiveness decreased by increasing of the level of pine leaf powder. In sensory evaluation, 10% pine leaf e sponge cake was better on taste, overall acceptability, and flavor. The results showed that sponge cake quality with 10% pine leaf powder was considered the best.

Keywords: pine leaf powder, sponge cakes, quality characteristics, specific gravity, texture analysis, sensory evaluation

INTRODUCTION

Pine leaf, widely distributed softwood including Korea, Japan and China has been used for health since early years. The main bioactive ingredients of the pine leaf are pinene, b-pinene, camphene, borneol, phellandrene, etc and also contain quercertin, kaempferol of flavonoids[1]. Pine leaf has been reported that it had been used for making alcohol, tea and juice in chinese medicine or folk remedy and prevent pain, diabetes, high blood pressure, skin disorders, atherosclerosis, stroke, eczema, kidney disease, depression, stroke, colds, gastroenteritis. There are number of the studies of the addition of pine leaf powder; antioxidant activity of noodle with added pine leaf powder[2], dough with added pine leaf powder[3], sausage with added pine leaf powder[4], the effect of pine leaf powder on blood and carcass characteristic[5], noodle with added extract and pine leaf powder[6], rice madeleine with added pine leaf powder[7], tofu with added pine leaf powder[8], antioxidant activity of rice cupcake with added extract and pine leaf powder[9], physiological activity of *Fomitella fraxinea* mycelium cultured from brown rice with added rice bran, pine leaf and curcuma[10]. Eggs, flour and sugar is used as a basic ingredient to make sponge cake.

Fundamental Procedure

A typical sponge cake is made by beating the eggs with sugar until they are light and foamy, then carefully sieving and folding in the flour. There are two primary ways of making sponge cake; one way is to separate yolks from whites of eggs and whip each separately. The other way is to whipping the egg white and yolk at once[11]. Recently with in-

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creasing consumers' interest and demand for functional foods, it is current trend to add new materials on the sponge cake; rice sponge cake with added ar tuberosus powder[12], Sponge cake with added cinnamon powder[13], sponge cake with added pakchio powder[14], sponge cake with added persimmon leaves powder[15] sponge cake supplemented with soy fiber flour[16], sponge cake with added laver powder[17] As described above, sponge cake with added pine leaf powder also can be involved in the new product family. Therefore, the objective of this study was to examine the selected physicochemical properties such as pH, color, texture, flavor, weight, specific gravity, baking loss, and consumer acceptances as influenced by the level of pine leaf powder incorporation(10, 20, 30, 40%) in cake making, and determine the appropriate level of incorporation based on the sensory acceptance.

MATERIAL AND METHOD

Materials

The materials used in the study were as follows : pine leaf 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. Pine leaf powder were added at the level of flour 0%(control), 10% (PNP10), 20%(PNP20), 30%(PNP30), 40%(PNP40). The material ratio of pine leaf powder and wheat flour was set through several preliminary experiments. The sponge cake prepared without pine leaf powder was designated as control group. The sponge cake with added pine leaf 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 pine leaf powder were the same as in the control group.

Preparation of a Sponge Cake with the Addition of Pine Needles Powder

Method of producing a sponge cake with the addition of pine leaf 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 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 analysis.

Table 1. Standard formula for sponge cakes with pine leaf powder (g)

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

[1)] Control: flour powder 100%.
[2)] PNP 10%: pine leaf powder 10% added.
[3)] PNP 20%: pine leaf powder 40% added.
[4)] PNP 30%: pine leaf powder 30% added.
[5)] PNP 40%: pine leaf powder 40% added.

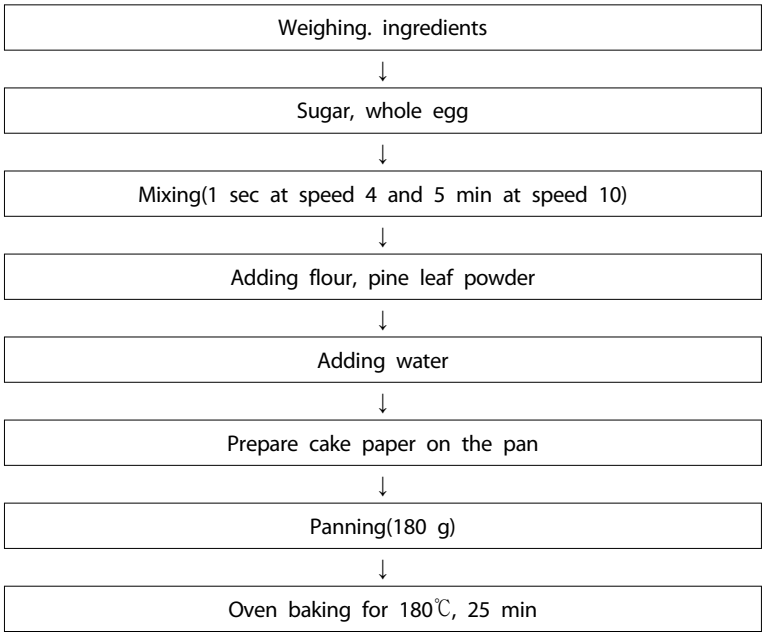

Figure 1. Diagram for making sponge cake containing pine leaf powder.

The Specific Gravity and pH of the Sponge Cake Batter with Added Pine Leaf Powder

The specific gravity of the sponge cake batter with added pine leaf powder was calculated using the equation below according to the AACC method 10~15[18].

$$\text{Specific gravity(\%)} = \frac{\text{W cup conaining} - \text{W cup}}{\text{W cup conation water - W empty cup}} \times 100$$

10grams 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 [18].

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 10~18[19]. The weight of sponge cake was measured with scale. The dough yield and baking loss were calculated with following equation.

$$\text{Water holding capacity(\%)} = \frac{\text{W batter before baking}}{\text{W cake after baking}} \times 100$$

$$\text{Baking loss(\%)} = \frac{\text{W batter} - \text{W cake}}{\text{W batter}} \times 100$$

Measurement of Volume and Specific Volume

The volume of sponge cake prepared with different ration of pine leaf powder was measured by the method of seed substitution. The specific volume was calculated with following equation.

$$\text{Specific volume(mL/g)} = \frac{\text{V sponge cake}}{\text{W sponge cake}} \times 100$$

Physicochemical Measurements of Sponge Cakes

The chromaticity of sponge cake (20×20×20 mm) was measured using a color 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 20mm), 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 AND DISCUSSION

Specific Gravity and pH

Table 2 shows the specific gravity and pH of the sponge cake batter with added pine leaf 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 influenced by the type of wheat flour, temperature, time and mixing conditions, mixing speed, existence and type of chemcal leavening agent. The specific gravity value of control group was 0.54 and gradually decreased as the added pine leaf powder increased, ranging from 0.50 to 0.54 in 10~40% sample groups. Similar result was reported for the rice cupcake prepared with pine leaf powder[20], sponge cake with added loutus root[21]. In terms of pH value, control group was measured to most lowest value of 6.91 and gradually increased as the added pine leaf powder increased, ranging from 5.90 to 6.50 in 10~40% sample groups. Other food ingredient such as yukwa prepared with *Lycil fructus* powder[22] caused similar increase in the pH value of sponge cake.

Cake Weight, Dough Yield and Baking Loss added Pine Leaf Powder

The weight of sponge cake batter with different ration of pine leaf 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

Table 2. Specific gravity and pH added pine leaf powder

Samples	Specific gravity	pH
Control	0.54±0.01[a1)]	6.91±0.10[a]
PNP 10%[2)]	0.54±0.00[a]	6.50±0.11[b]
PNP 20%	0.52±0.00[b]	6.43±0.05[a]
PNP 30%	0.50±0.02[c]	6.24±0.11[b]
PNP 40%	0.49±0.01[d]	5.90±0.01[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)] PNP : pine leaf powder.

Table 3. Cake weight, dough yield and baking loss added pine leaf powder

Samples	Cake weight(g)	Dough yield rate(%)	Baking loss rate(%)
Control	302.2±2.00[a1)]	132.45±0.03[a]	9.09±0.01[a]
PNP 10%[2)]	300.6±1.15[a]	133.33±0.33[a]	8.89±0.01[b]
PNP 20%	301.3±1.15[a]	132.70±0.58[ab]	8.69±0.01[c]
PNP 30%	301.3±3.06[a]	132.89±0.90[b]	8.74±0.13[c]
PNP 40%	302.6±2.31[a]	132.45±0.33[a]	8.27±0.013[d]

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

samples. However, after baking, the control was measured to lowest value of 302.2 and those of 10~40% samples ranged from 300.6 to 302.6. As the amount incorporated into the formulation 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[23]. The dough yield of sponge cake in control group was 100.2% and gradually increased as the amount incorporated into the formulation increased, ranging 300.6% to 306.6% 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 9.09% and tended to decrease as the pine leaf powder content increased, ranging from 8.89% to 8.27% in 10~40% sample groups. Similar result was found for sponge cake made with pine leaf powder[24], sponge cake made with Ecklonia cava powder[25].

Cake Height, Volume and Specific Volume added Pine Leaf 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 6.86cm and tended to decreased as pine leaf powder content increased, ranging from 5.28% to 6.40% in 10~40% sample groups. Similar result was found for sponge cake made with *beaknyuncho* powder [26]. Volume and specific volume added pine leaf powder were measured with the method of seed substitution. The volume was highest for the control cake with 687.33 cm^3 and those of samples ranged from 652.00 to 606.00 cm^3. As pine leaf powder content increased, the volume tended to decreased significantly. In terms of specific volume, the value of control cake was observed to 2.29cm^3/g and those of 10~40% sample groups ranged from 1.83 to 2.16 cm^3/g. This indicates that the control cake had the highest specific volume, which decreased in proportion to the level of pine leaf 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 pine leaf powder. A similar finding was reported for the sponge made with lotus leaf and lotus root powder[27].

Color Evaluation

The L(lightness) value of the sponge cake incorporated with different levels of pine leaf powder was shown in Table 5. The L value of the control cake was observed to 49.68 and those of sample groups ranged from 35.18 to 46.79. This indicates that the control cake had the highest brightness, which decrease in proportion to the level of the pine leaf powder(p<0.001). Similar decreases in L are caused by the incorporation of other food ingredient powders such as parprka[28] and laver[29]. Hunter a value (redness) of the control cake was 1.10 and gradually increased as the added pine leaf powder increased, resulting in the highest value of 6.42 for the cake containing 40% pine leaf powder.

Table 4. Cake hight, volume and specific volume added pine leaf powder

Samples	Cake hight(cm)	Volume(cm^3)	Specific volume(cm^3/g)
Control	6.86±0.01a[1)]	687.33±5.03[a]	2.29±0.01[a]
PNP 10%[2)]	6.40±0.10[b]	652.00±5.29[b]	2.16±0.01[b]
PNP 20%	5.66±0.02[a]	623.33±14.47[b]	1.89±0.01[c]
PNP 30%	5.92±0.15[a]	609.33±9.02[cd]	1.84±0.01[d]
PNP 40%	5.28±1.10[a]	606.00±5.29[d]	1.83±0.01[d]

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

Hunter *b* value (yellowness) of the control cake was the highest with 28.68 and decreased with the increasing level of the pine leaf powder, showing the value of 24.04~22.37 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 pine leaf powder added groups are considered to be attributable to the own color the pine leaf powder have itself. Formulation of the pine leaf powder with other food such as noodle[30] and matrimony vine 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 in coporation of pine leaf 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 pine leaf powder(0, 10, 20, 30, 40%). The were determined as follows in Table 5. The hardness of the 10~40% samples group ranged 959.93 to 1156.75 was significantly higher than the control measured to 828.92 (g/cm^2). In fact, the hardness value was significantly increased as the amount of pine leaf 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 pine leaf 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. Similar re-

Table 5. Hunter's color value of sponge cake added pine leaf powder

Samples	L	a	b
Control	49.68±0.33[a1)]	1.10±0.01[a]	34.32±0.10[a]
PNP 10%[2)]	46.79±0.28[b]	3.05±0.42[c]	24.04±0.05[a]
PNP 20%	45.19±0.66[b]	4.10±0.12[a]	23.97±0.33[b]
PNP 30%	37.93±1.30[c]	5.19±0.14[c]	22.77±0.66[c]
PNP 40%	35.18±0.43[b]	6.42±0.10[c]	22.37±1.05[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)] PNP : pine leaf powder.

Table 6. Texture properties of sponge cake added pine leaf powder

Samples	Hardness(g/cm^2)	Springiness(%)	Cohesiveness(%)
Control	828.92±2.26$^{a1)}$	0.84.±0.04^a	0.48±0.01^a
PNP 10%$^{2)}$	959.93±1.07^b	0.80±0.01^a	0.48±0.02^a
PNP 20%	1,175.14±4.25^c	0.83±0.06^b	0.45±0.03^b
PNP 30%	1,183.82±2.26^a	0.74±0.09^a	0.42±0.16^c
PNP 40%	1,256.75±3.21^c	0.73±0.01^a	0.40±0.12^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) PNP : pine leaf powder.

sult was found for the sausage with added pine leaf powder[31] and sponge cake with added *Cudrania tricuspidata* leaf powder[32]. The springiness value was highest for control group with 0.84 and significantly decreased, from 0.80 to 0.73 as added the pine leaf powder increased in the formulation. The cohesiveness value of control group was highest with 0.47 and gradually decreased with increasing the level of pine leaf powder, showing the value of 0.40~0.48 in 10~40% sample groups(p<0.001). The sponge cake with added pumpkin puree[33] and sponge cake with added artichoke powder[34] 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 pine leaf 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 4.9. and 10~40% sample ranged from 4.0 to 4.7 In fact, the appearance acceptance decreased as the percent of pine leaf powder incorporation increased in the formulation.

The consumer preferences on flavor were significantly affected by the amount of pine leaf powder incorporated in the sample. In the acceptability of flavor, the control received 4.5 and 10~40% sample ranged 3.7 to 4.6 This result is consistent with the study of the rice cake with added pine leaf[34] and cookie with added pine leaf powder[35].

In terms of taste, the control received the most

Table 7. Sensory properties of sponge cake added pine leaf powder

Samples	Appearance	Flavor	Taste	Texture	Overall acceptability
Control	4.9±1.50$^{a1)}$	4.5±1.52^a	4.5±1.80^a	4.6±0.1^a	4.7±1.51^a
PNP 10%$^{2)}$	4.7±1.58^a	4.6±1.58^a	4.5±1.81^a	4.5±0.5^b	4.8±1.66^a
PNP 20%	4.5±1.55^a	4.3±1.54^a	4.0±1.54^{ab}	4.3±0.1^b	4.1±1.70^b
PNP 30%	4.3±1.70^b	4.0±2.02^{ab}	3.7±2.02^b	4.0±0.1^a	3.9±1.08^b
PNP 40%	4.0±1.92^b	3.7±2.09^b	3.5±2.09^b	3.9±0.2^a	3.8±1.63^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) PNP : pine leaf powder.

favorable mean scores of 4.5 and 10~40% sample received relatively low scores ranged 3.5 to 4.5. There were significant differences found among the samples(p<0.001). In terms of texture, the control received 4.6 and 10~40% sample ranged from 3.9 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 4.6 and tended to decreased, from 4.5 to 3.9, with the increasing level of pine leaf powder. Similar result was found for the study on uniformity and moisture of pore, the importance of the cake with suitable volume, uniform organization, soft feel[36] and cookie made with lycii fructus[37]. Therefore, the results indicated that substituting 10% pine leaf powder to sponge cake is optimal for quality and provides a product with reasonable high overall acceptability.

RESULT AND DISCUSSION

This study was conducted to evaluate the effect of pine leaf powder on the quality characteristics of sponge cake. Pine leaf powder sponge cake was prepared with different ration of pine leaf powder(0, 10, 20, 30, 40%). The Specific gravity value of control group was 0.54 and gradually decreased as the added pine leaf powder increased, ranging from 0.50 to 0.54 in 10~40% sample groups. In terms of pH value, control group was measured to most lowest value of 6.91 and gradually increased as the added pine leaf powder increased, ranging from 5.90 to 6.50 in 10~40% sample groups. However, after baking, the control was measured to lowest value of 302.2 and those of 10~40% samples ranged from 300.6 to 302.6. As the amount incorporated into the formulation increased, the weight of sponge cake significantly decreased(p<0.001). The dough yield of sponge cake in control group was 100.2% and gradually increased as the amount incorporated into the formulation increased, ranging 300.6% to 306.6 % in 10~40% sample groups. This result is considered to be due to the difference between the weight of the samples. In terms of baking loss, the control was 9.09% and tended to decrease as the pine leaf powder content increased, ranging from 8.89% to 8.27% in 10~40% sample groups.

The height value of sponge cake was highest for control group with 6.86cm and tended to decreased as pine leaf powder content increased, ranging from 5.28% to 6.40% in 10~40% sample groups. The volume was highest for the control cake with 687.33 cm^3 and those of samples ranged from 652.00 to 606.00 cm^3. In terms of specific volume, the value of control cake was observed to 2.29cm^3/g and those of 10~40% sample groups ranged from 1.83 to 2.16cm^3/g. The L value of the control cake was observed to 49.68 and those of sample groups ranged from 35.18 to 46.79. Hunter a value (redness) of the control cake was 1.10 and gradually increased as the added pine leaf powder increased, resulting in the highest value of 6.42 for the cake containing 40% pine leaf powder. Hunter b value (yellowness) of the control cake was the highest with 28.68 and decreased with the increasing level of the pine leaf powder, showing the value of 24.04~22.37 in 10~40% samples(p<0.001). The hardness of the 10~40% samples group ranged 959.93 to 1,156.75 was significantly higher than the control measured to 828.92(g/cm^2). In fact, the hardness value was significantly increased as the amount of pine leaf powder incorporated in the formulation increased. The springiness value was highest for control group with 0.84 and significantly decreased, from 0.80 to 0.73 as added the pine leaf powder increased in the formulation. The cohesiveness value of control group was highest with 0.47 and gradually decreased with increasing the level of pine leaf powder, showing the value of 0.40~0.48 in 10~40% sample groups(p<0.001). In terms of appearance, the control received the most favorable mean scores of 4.9. and 10~40% sample ranged from 4.0 to 4.7 In fact, the appearance acceptance decreased as the percent of pine leaf powder incorporation increased in the formulation.

The consumer preferences on flavor were significantly affected by the amount of pine leaf powder incorporated in the sample. In the acceptability of flavor, the control received 4.5 and 10~40% sample ranged 3.7 to 4.6. In terms of taste, the control received the most favorable mean scores of 4.5 and 10~40% sample received relatively low scores ranged 3.5 to 4.5. In terms of texture, the control received 4.6 and 10~40% sample ranged from 3.9 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 4.6 and tended to decreased, from 4.5 to 3.9, with the increasing level of pine leaf powder. Therefore, the results indicated that substituting 10% pine leaf powder to sponge cake is optimal for quality and provides a product with reasonable high overall acceptability.

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