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Physicochemical Qualities and Consumer Acceptance of Chocolate Layer Cake

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ABSTRACT Physicochemical qualities and consumer acceptability of chocolate layer cake were studied with varied levels of rosemary powder at 0, 0.2, 0.4 and 0.6%. The ash content of the cake increased from 2.30 to 3.10%, as the amount of rosemary powder increased from 0 to 0.6%, and the carbohydrate content of the cake decreased as the addition of rosemary powder increased. There were no significant differences in moisture contents and pH values among the samples and the pH values of all samples were within the typical pH range of 7.5-8.0 for chocolate layer cakes. Water loss from the control cake was greater than that from the cakes with rosemary powder supporting the suggestion that the addition of rosemary powder to the chocolate layer cake could increase moisture retention of the cake. Consumer acceptability of all the samples showed higher preferences of more than 7 points. Rosemary aroma, mint flavor and after taste were highly positively correlated with the fat content. Fat and ash content of the cake, which tended to increase in proportion to the rosemary powder content, were negatively correlated with acceptance of herb flavor, sweet taste, moistness, softness and intensity of softness but positively correlated with intensity of herb flavor. With the results above, trials on chocolate layer cake using rosemary powder were successfully performed within the ranges tested.

KEYWORDS: *chocolate layer cake, rosemary powder, physicochemical, sensory properties*

INTRODUCTION

Eating a healthy, balanced, varied diet is important for an individual's health, but sometimes it is difficult to achieve with today's hectic lifestyle. Hence, it is a good idea to supplement the diet with at least a good quality food. Bakery products are a good source of food supplements as various ingredients can be added to them to enhance their nutritional or functional properties. As the consumer's desire for healthy food increases, bakers try to develop value-added and nutritious fresh bakery products using white, whole wheat and whole grains or green tea powder, beans, fibers or chlorella (1). Many traditional herb and spice combinations with food are known to have a medicinal or utilitarian origin. For example, the common use of thyme with meat originates from an early practice of rubbing fresh thyme into meat to help keep meat fresh longer. A recent medical finding suggests that bacteria may contribute to the development of obstructions in the heart and arteries. Current thinking is that treatment with antibiotics might help clear such obstructions. This may point to a similar role for herbs and spices like curry in food, where the liberal use of these in our diets may help to keep the vascular system clear (2,3). For example, garlic is used in curries and its antibiotic properties have been more extensively studied than some of its other reputed health benefits. Herbs like garlic are known to contain many nutrients and beneficial alternative medicines that nourish the body. Medicinal herbs have been used safely and effectively since recorded history, for an endless list of health purposes, from weight control to increasing longevity. Herbs are said to help the body by supplying nutrients which the body does not always receive, either because of a poor diet, or due to environmental deficiencies in the soil and air. That is why herbs are well known as balancers that help regulate body functions. Herbs have been used in cooking to add flavor, or as a medicine (4). Rosemary (*Rosmarinus officinalis*) is a woody, perennial herb with fragrant evergreen needle-like leaves. It is native to the Mediterranean region. It is a member of the mint family Lamiaceae, which also includes many other herbs. It is 1 inch long, needle-shaped leaves, and has a strong sharp camphor-like aroma and has long been used as a popular flavoring in soups, stews, meat

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preparations and breads (5). The constituents of rosemary include essential oils, flavonoids, phenolic acids, and triterpene (6). Rosemary has many uses. It has antibacterial and antifungal actions which enhance the function of the immune system and it increases the blood circulation to the skin causing perspiration. It is useful for bringing down a fever, stimulating the clearing of phlegm from the head and chest, relieving coughs, colds and flu, catarrh, wheezing, bronchitis, and whooping cough. It also stimulates the heart, brain and nervous system by increasing blood flow. It enhances appetite, increases the flow of digestive juices, improves the flow of food through the digestive tract and assists in the absorption of nutrients. The bitter taste of the rosemary is said to stimulate the liver and gallbladder increasing the flow of bile and aiding in the digestion of fats. It has other functions as a rejuvenating tonic and is said to slow the aging process and stimulate the hair follicles and may therefore be useful in preventing premature baldness. Rosemary oil is effective externally to ease muscle pain, sciatica and neuralgia (7,8). Additions of rosemary to Korean *Kimchi* reduced the total bacteria counts during storage (9). In addition, Debersac *et al.* (10) reported that the rosemary leaf included rosmarinic, carnosic and ursolic acids which had a significantly higher antioxidant capability than vitamin E. Most of the research on herbs including rosemary have been made on the anti-oxidative (11-14) anti-mutagenic (15) or anti-thrombus effects (16) of the herbal oil and extract.

There have been a few trials on the enhancement of breads or cakes by adding herbs (12,17,18). But, to date, there have been no trials on adding rosemary powder to cake. In this study, chocolate layer cakes were developed using rosemary and the physicochemical properties and consumer acceptance of the cakes were investigated.

MATERIALS AND METHODS

Materials

Fresh rosemary (Herb Nongwon, Yongin, Korea) and rosemary powder (produced in USA, imported by Eunjin Industrial Co., Yongin, Korea and milled by Yuam Industrial Co., Seoul, Korea, respectively) were purchased at a local market. Soft wheat flour (CJ Co., Seoul,), sugar (CJ Co.), cocoa powder (a mixture of 95% cocoa powder and 5% sugar) (Osung Foods Co., Ansan, Korea), baking soda (a mixture of sodium hydrogen carbonate and corn starch) (Shinjin Foods Co., Gwangju, Korea), baking powder (a mixture of sodium bicarbonate and pyrophosphate) (Shinjin Foods Co.), vanilla powder (Shinjin Foods Co.), shortening (Heinz Korea Ltd.), milk (Seoul Milk, Seoul), eggs and salt were also used for the cake formulas.

Proximate analysis

Fresh rosemary leaves and rosemary powder were analyzed in three replications for moisture, protein (N × 5.95), fat and ash using the AOAC methods (19). The same analysis was performed for the chocolate layer cakes prepared using following process.

Table 1. Formulation of chocolate layer cakes[1)]

Ingredients	Amount (% flour weight basis)			
	0%	0.2%	0.4%	0.6%
Cake flour	100	100	100	100
Granulated sugar	170	170	170	170
Salt	3.75	3.75	3.75	3.75
Cocoa powder	40	40	40	40
Baking soda	3.75	3.75	3.75	3.75
Baking powder	3.6	3.6	3.6	3.6
Eggs (whole)	90	90	90	90
Milk	80	80	80	80
Shortening	75	75	75	75
Vanilla powder	3	3	3	3
Water	57	57	57	57
Rosemary powder	0	0.2	0.4	0.6

[1)]Cakes in which rosemary powder was added at 0, 0.2, 0.4 and 0.6%.

Preparation of Chocolate Layer Cake

Chocolate layer cake was prepared with modification of the standard cake formula AACC mixing method 10-90 (20). The control cake contained 0% rosemary powder based on the flour weight. The rest of the formulations contained 0.2, 0.4, and 0.6% rosemary powder respectively (Table 1). Dry ingredients were sieved, and then shortening was added. Eggs, milk and water were mixed and warmed up to 52°C in a double boiler. 60% of the liquid mixture was added to the dry ingredients and mixed 30 sec at speed no. 2 (Kitchen Aide mixer K5SS, MI) using wire whip. The batter was scraped down and mixed at speed no. 6 for 2 min. The batter was scraped down again and remained 40% of the liquid mixture was added and mixed at speed no. 6 for 1 min. Batter (650 g) was poured into a lightly greased pan (20 cm diameter), baked at 160/180°C for 35 min in an electric oven (HSDO 2002, Han Young Bakery Machinery Co., Seoul, Korea) and cooled down at room temperature for 1 h.

Batter moisture content, pH and water loss of cake

The moisture content of the cake batters was measured at 110°C (Convection oven J-FOV1, Jeil, Seoul) using the AOAC methods. Batter pH was measured with a homogenate of 5 g of batter in 45 mL of distilled water (Corning pH meter 440, USA) (21). To investigate the water loss during the baking, the difference in weight of pan containing the batter and the pan with baked cake was measured (22).

Consumer Acceptance Test

Consumer acceptance test was conducted for the cakes

using the Hedonic scale (23). 105 university students (52 male/53 female) were participated as the panel. The test was composed of 9 questions with response ranges from "Dislike extremely" (left-most) to "Like extremely" (right-most) and 9 labeled increments in-between. 4 different colors were used to distinguish each sample (blue for 0%, yellow for 0.2%, green for 0.4%, and red for 0.6% cake) and the panel was asked to write down the color of the sample first. The evaluated attributes were overall acceptability, herb flavor, sweetness, moistness, and softness. Intensity for each attribute except overall acceptability was also evaluated.

Statistical Analysis

Three replicates were completed except the consumer acceptance test, which was conducted once, and data were analyzed by a randomized block design. Analysis of variance (ANOVA) was performed to test the differences among the treatments (24). When significant differences were found among the treatments, Ducan's multiple range tests were performed to determine the differences among the mean values. Also the Pearson's correlation coefficients (γ) between the consumer acceptance test and physicochemical characteristics were calculated.

RESULTS AND DISCUSSION

Proximate analysis of rosemary

Table 2 shows the results of proximate analysis of fresh rosemary and rosemary powder. The moisture (7.04%) and ash (7.33%) contents of rosemary powder were significantly lower than those of fresh rosemary leaf. In contrast the protein (5.75%), fat (28.97%), and carbohydrate (50.91%) contents of rosemary powder were significantly higher than those of fresh rosemary leaf (4.61, 14.99, and 8.61% respectively). These data were similar to the results of the proximate analysis of rosemary leaf reported by Kim (25).

Moisture content and pH of batter

There were no significant differences in moisture contents (32.90-33.49%) and pH values (7.90-7.95) among the samples (Table 3). The pH values of all samples were found to be within the typical pH range for chocolate layer cake (7.5-8.0) (26).

Proximate analysis and water loss of Cake

As shown in Table 4, the ash content of the cake also increased from 2.30 to 3.10%, as the amount of rosemary powder increased from 0 to 0.6%. The carbohydrate content of the cake decreased, ranging from 53.25 (0%) to 46.79% (0.6%), as the addition of rosemary powder increased. In contrast, there were no significant differences in moisture and protein contents among the samples, which ranged from 30.55 to 32.25% and 4.21 to 5.22%, respectively.

Water loss from the control cake (s) (52.56 g) was greater than from the cakes containing rosemary powder (49.61-51.01 g), among which the sample containing 0.6% showed the lowest loss. These data are consistent with the results of Park and Chung (27) who reported that an addition of 3% of the herb to bread resulted in a lower moisture loss than from the control. In Jo and Lee's study (28) it was found that as the level of added dietary fiber increased, the moisture absorption of the bread batter also increased. The results of this study supported the suggestion that the addition of rosemary powder to chocolate layer cake could increase the moisture retention of the cake, resulting in a more moist product compared to the control.

Consumer acceptance and intensities of the cake

The results of the consumer acceptance test on the cake samples are given in Table 5. For herb flavor, sweet taste, and moistness, the control cake showed a higher level of acceptability, than the rosemary powder-added cakes, with the values of 5.8, 6.5, 7.4, respectively. Regarding the

Table 2. Proximate composition[1)] of fresh rosemary leaves and rosemary powder[2)]

	Moisture	Crude protein	Crude lipid	Ash	Carbohydrate
Fresh rosemary	58.45 ± 0.71[a]	4.61 ± 0.28[b]	14.99 ± 0.45[b]	13.33 ± 2.31[a]	8.61 ± 3.47[b]
Rosemary powder	7.04 ± 0.24[b]	5.75 ± 0.22[a]	28.97 ± 1.19[a]	7.33 ± 0.70[b]	50.91 ± 0.84[a]

[1)]per 100 g
[2)]Values followed by the same letter in the same column are not significantly different ($p < 0.05$). Mean values of three replicates.

Table 3. Moisture content and pH of chocolate layer cake batters[1,2)] with varied levels of the rosemary powder

	Varied levels of the powder to cake batters			
Variable	0%	0.2%	0.4%	0.6%
Moisture (%)	33.45 ± 0.49[a]	33.28 ± 0.22[a]	33.49 ± 0.62[a]	32.90 ± 0.56[a]
pH	7.95 ± 0.04[a]	7.91 ± 0.09[a]	7.90 ± 0.04[a]	7.92 ± 0.08[a]

[1)]Cake batters in which rosemary powder was added at the level of 0, 0.2, 0.4, and 0.6%.
[2)]Values followed by the same letter in the same column are not significantly different ($p < 0.05$). Mean values of three replicates.

Table 4. Proximate analysis and water loss of chocolate layer cakes[1,2)]

Measured variable	Varied levels of the powder to cakes			
	0%	0.2%	0.4%	0.6%
Moisture[3)]	32.25 ± 0.50[a]	30.55 ± 0.50[a]	30.55 ± 0.50[a]	31.15 ± 0.50[a]
Crude protein[3)]	4.21 ± 0.03[a]	4.58 ± 0.04[a]	4.78 ± 0.04[a]	5.22 ± 0.93[a]
Crude lipid[3)]	8.00 ± 0.00[d]	10.80 ± 0.42[c]	12.55 ± 0.07[b]	13.75 ± 0.35[a]
Ash[3)]	2.30 ± 0.14[b]	2.75 ± 0.07[ab]	2.95 ± 0.07[a]	3.10 ± 0.28[a]
Carbohydrate[3)]	53.25 ± 0.60[a]	51.33 ± 0.88[ab]	49.17 ± 0.54[bc]	46.79 ± 0.78[c]
Water loss	52.56 ± 0.90[a]	51.01 ± 1.15[ab]	50.81 ± 0.50[ab]	49.61 ± 0.47[b]

[1)]Cake batters in which rosemary powder was added at the level of 0, 0.2, 0.4, and 0.6%.
[2)]Values followed by the same letter in the same column are not significantly different ($p < 0.05$). Mean values of three replicates.
[3)]Composition per 100 g.

Table 5. Consumer acceptance and intensities of chocolate layer cakes with rosemary powder[a,b]

Measured variable		Cakes			
		0%	0.2%	0.4%	0.6%
Acceptance	Herb flavor	5.8 ± 1.8[a]	5.2 ± 1.8[b]	4.9 ± 2.0[b]	4.9 ± 2.1[b]
	Sweet taste	6.5 ± 1.7[a]	6.1 ± 1.7[b]	6.0 ± 1.9[b]	5.8 ± 2.0[b]
	Moistness	7.4 ± 1.4[a]	7.0 ± 1.8[b]	7.0 ± 1.7[b]	6.9 ± 1.7[b]
	Softness	7.5 ± 1.6[a]	7.3 ± 1.7[a]	7.1 ± 1.8[a]	7.1 ± 1.7[a]
Intensity	Herb flavor	4.0 ± 2.2[c]	5.8 ± 2.2[b]	6.2 ± 2.2[ab]	6.7 ± 1.9[a]
	Sweet taste	6.1 ± 1.7[a]	5.3 ± 1.8[b]	5.4 ± 1.7[b]	5.3 ± 2.0[b]
	Moistness	6.9 ± 1.7[a]	6.7 ± 1.8[a]	6.7 ± 1.8[a]	6.6 ± 1.9[a]
	Softness	6.9 ± 1.8[a]	6.7 ± 1.8[a]	6.7 ± 1.8[a]	6.6 ± 2.0[a]

[a]Cakes in which rosemary powder was added at the level of 0, 0.2, 0.4, and 0.6%.
[b]Values followed by the same letter in the same column are not significantly different ($p < 0.05$). Mean values of three replicates.

Table 6. Correlations (γ) between consumer acceptance and physicochemical properties of cakes

Measured variable	HF	ST	MO	SO	IHF	IST	IMO	ISO
Protein	-0.89	-0.98*	-0.90	-0.93	0.93	-0.77	-0.90	-0.97*
Fat	-0.98*	-0.99**	-0.96*	-0.99*	0.98*	-0.87	-0.94	-0.98*
Ash	-0.98*	-0.99**	-0.98*	-0.99*	0.99**	-0.90	-0.96*	-0.99*
Carbohydrate	0.90	0.97*	0.88	0.94	-0.91	0.74	0.87	0.95
Moisture content	0.80	0.68	0.84	0.74	-0.79	0.93	0.80	0.70
Water loss	0.91	0.99**	0.94	0.93	-0.96*	0.85	0.96*	0.99**

*, $p < 0.05$; **, $p < 0.01$.
[a]HF, herb flavor; ST, sweet taste; MO, moistness; SO, softness; IHF, intensity of herb flavor; IST, intensity of sweet taste; IMO, intensity of moistness; ISO, intensity of softness.

softness of the cake texture, all of the samples had the values of more than 7 (7.1-7.5), while no significant differences were examined among them. The intensity of herb flavor of the cake containing 0.6% rosemary powder (6.7) was greatest, while that of the control had the lowest intensity (4.0) (Table 5). The control cake had a significantly higher intensity of sweet taste (6.1), compared to the rosemary powder-added samples (5.3-5.4). There were no significant differences in the intensities of moistness and softness among the samples.

Correlation between Consumer Acceptance and Physicochemical Characteristics

Correlations between consumer acceptance and physicochemical characteristics for the cakes are summarized in Table 6. Regarding the herb flavor, fat ($r = -0.98$, $p < 0.05$) and ash content ($r = -0.98$, $p < 0.05$) were negatively correlated. For moistness, fat ($r = -0.96$, $p < 0.05$) and ash contents ($r = -0.98$, $p < 0.05$) had negative correlations. Softness was negatively correlated with fat ($r = -0.99$,

$p < 0.05$), and ash content ($r = -0.99$, $p < 0.05$) of the cake. In addition, sweet taste was positively correlated with carbohydrate content ($r = 0.97$, $p < 0.05$) and water loss ($r = 0.99$, $p < 0.01$), but negatively correlated with crude protein ($r = -0.98$, $p < 0.05$), fat ($r = -0.99$, $p < 0.01$), and ash content ($r = -0.99$, $p < 0.01$). The intensity of herb flavor was positively correlated with fat ($r = 0.98$, $p < 0.05$) and ash content ($r = 0.99$, $p < 0.01$), but negatively correlated with water loss ($r = -0.96$, $p < 0.05$). There were no significant correlations between the intensity of sweet taste and any of the physicochemical properties. Moistness was significantly positively correlated with water loss ($r = 0.96$, $p < 0.05$), but negatively correlated with ash content ($r = -0.96$, $p < 0.05$). Finally, softness was significantly positively correlated with water loss ($r = 0.99$, $p < 0.01$), but negatively correlated with protein ($r = -0.97$, $p < 0.05$), crude lipid ($r = -0.98$, $p < 0.05$), and ash content ($r = -0.99$, $p < 0.05$). Interestingly, the fat and ash content of the cake, which tended to increase in proportion to the rosemary powder contents, were negatively correlated with overall acceptability, herb flavor, sweet taste, moistness, softness and intensity of softness but positively correlated with the intensity of the herb flavor. Trials on the development of chocolate layer cakes using rosemary powder were successfully performed within the ranges tested.

REFERENCES

1. Pack SB. 1990. Quality improvement of healthy breads. Monthly Breads and Cakes. 8: 34.
2. Cho YJ, Kim JW, Yoon SJ, Chun SS, and Choi WK. 2005. A study on the salubrious functions of the rosemary extract. Kor J Food Sci Technol. 37: 970-975.
3. Craig WJ. 1999. Health-promoting properties of common herbs. Am J Clin Nutr. 70: 491-499.
4. Labensky S, Ingram GG, and Labensky SR. 1997. Webster's New World Dictionary of Culinary Arts. Prentice Hall. NJ, USA. p. 190.
5. Farrow J. 2001. Herbs. LB. New York, USA. pp. 56.
6. Cuvelier ME, Richahard H, and Berset C. 1998. Antioxidative activity of phenolic composition of pilot plant and commercial extracts of sage and rosemary. J Am Oil Chem Soc. 73: 645-652.
7. Lee SH. 1992. Aroma Therapy. Hongikjae. Seoul, Korea. p.78.
8. Yoo MY, Jung YJ, and Yang JY. 2005. Antiseptic effects of herbal extract. Kor J Soc Food Nutr Sci. 34: 1130-1135.
9. Moon KD, Beyon JA, Kim SJ, and Han DS. 1995. A study on the natural preservatives for the preservation of Kimchi. Kor J Soc Food Nutr Sci. 27: 257.
10. Debersac P, Vernevaut MF, Amiot MJ, Suschetet M, and Siess MH. 2001. Effect of a water-soluble extract of rosemary and its purified component rosemarnic acid on xenobiotic-metabolizing enzymes in rat liver. Food Chem Toxicol. 39: 109-117.
11. Chang SS, Biserka OM, Oliver AL, and Huang CL. 1997. Natural antioxidants from rosemary and sage. J Food Sci. 42: 1102.
12. Elena I, Alejandro C, Antonio LC, Francisco JS, Sofia C, and Guillermo R. 2000. Combined use of supercritical fluid extraction, micellar electrokinetic chromatography, and reverse phase high performance liquid chromatography for the analysis of antioxidants from rosemary. J Agric Food Chem. 48: 4060-4065.
13. Wei Z, and Shiow YW. 2001. Antioxidant activity and phenolic compounds in selected herbs. J Agric Food Chem. 49: 5165-5170.
14. Ryoo JW, and Cha BC. 1998. Mineral content and antioxidative activity in some herb plants. Kor J Med Crop Sci. 6: 28-32.
15. Ham SS, Oh DH, Hong JK, and Lee JH. 1997. Antimutagenic effects of juices from edible Korean wild herbs. Kor J Food Sci Nutr. 2: 155-161.
16. Lee JY, Lee HS, Jeon WJ, You KW, Shin DH, Hong BS, Jo HY, and Yang HC. 2000. Investigations on the anti-coagulant effect of herbal extract. Kor J Soc Food Nutr Sci. 29: 335-341.
17. Kim YA. 2003. Effect of mulberry leaves powder on the quality characteristics of yellow layer cakes. Kor J Food Sci Technol. 35: 871-876.
18. Seong BS. 2002. Textural and sensory characteristics of herb added bread. Graduate School of Chodang Univ. Muan. Korea.
19. AOAC. 1995. Official methods of analysis, 16th edn. Assoc. of Official Analytical Chem. Arlington, VA, USA.
20. AACC. 1999. Official methods of AACC. Method 10-91. Am. Assoc. Cereal Chem. St. Paul, MN, USA.
21. Fondroy EB, White PJ, and Prusa KJ. 1989. Physical and sensory evaluation of lean white cakes containing substituted fluffy cellulose. Cereal Chem. 66: 402-404.
22. Song ES, Kim SJ, and Kang MH. 2002. Physical and sensory characteristics of low calorie layer cake made with different levels of hydrolyzed oat flour. Kor J Food Sci Tecnhol. 34: 51-56.
23. Price C, Morris JR, and Danforth DM. 1993. Consumers evaluate Arkansas blueberry-grape juice blends. Arkansa Farm Resear. 1: 10-11.
24. SAS Institute. 2001. SAS User's Guide Version 8. SAS Institute. Cary, NC, USA.
25. Kim JY. 2002. A study on the development of herb-added rice cake. Graduate School of Chodang Univ. Muan. Korea.
26. Ash DJ, and Colmey JC. 1973. The role of pH in cake baking. Baker's Digest. 47: 36-42.
27. Park ID, and Chung DO. 2003. Studies on the physiological and sensory properties of herb bread. Kor J Soc Food Cookery Sci. 19: October.
28. Jo MK, and Lee WJ. 1996. Development of high fiber bread using barley powder. Kor J Food Sci Technol. 28: 702.