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Chemical Composition of *Smilax china* Leaves and Quality Characteristics of Rice Cakes Prepared with Its Water Extract

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Abstract The chemical composition of *Smilax china* leaves and the quality characteristics of *seolgitteok* (rice cake) prepared with a water extract of these leaves were evaluated. Sucrose, glucose, maltose, and fructose were found as free sugars in the leaves, while the main fatty acids were stearic and palmitic acids. Glutamic acid and potassium were found at the highest levels among the analyzed amino acids and minerals in the leaves, respectively. On a fresh weight basis, the content of total phenolics and condensed tannin was 1.26 and 0.74%, respectively. As the amount of *S. china* leaf extract increased, the lightness of *seolgitteok* significantly decreased ($p<0.001$) in the rice cake, while redness and yellowness of the cake increased. Texture evaluation showed that springiness, strength, and cohesiveness were higher in rice cakes prepared with 2% *S. china* leaf extract compared to rice cakes made with 1% extract. At the beginning of the storage period (20°C), there were no significant differences in viable aerobic cell and mold counts among rice cakes, but after four days in storage, a significant reduction in microorganisms was observed in rice cakes prepared with increasing amounts of leaf extract. On sensory evaluation, rice cakes made with 1% water extract from *S. china* leaves scored the highest on flavor, taste, texture, and overall acceptability.

Keywords: *Smilax china* leaves, chemical composition, *seolgitteok*, texture and sensory evaluation, microorganism

Introduction

Increased interest in personal health due to recent westernization and changes in food habits has increased the demand for functional foods, or foods that have physiological benefits (1). As a result, development of food products with physiologically active ingredients or natural products has also been increasingly reported (2-4). In particular, plant leaves containing high amounts of chlorophyll, vitamins A, C, and E, and flavonoids, as well as the water extracts of such leaves, have been used for many medicinal purposes such as anti-obesity and anti-carcinogen treatments and to defend against the degenerative diseases of aging (3-5). Functional food applications have been reported for mulberry leaves (6), pine needles (7), and persimmon leaves (8).

Smilax china has been used as a traditional remedy in Korea for inflammatory diseases and ischuria (5). Several reports describe the physiological properties of this medicinal plant (5, 9-11). Song *et al.* (10) showed that the methanol, chloroform, ethyl acetate, and butanol extracts of *S. china* root exhibited potent antimicrobial activities. The extracts of *S. china* also inhibited the mutagenicity of benzo[a]pyrene (5), scavenged free radicals and inhibited the formation of lipid peroxides (11). Recently, Jin *et al.* (9) investigated the antioxidant properties of *S. china* leaves and reported that the ethyl acetate fraction of the leaves had electron donating abilities and nitrite scavenging effects. However, little research has been done on the chemical composition of *S. china* leaves or their application to functional food.

In Korea, *S. china* leaves, a popular herbal medicinal plant, were traditionally used to wrap rice cakes to supply good flavor and antimicrobial activity (12). *Seolgitteok*, a kind of steamed rice cake, is traditionally eaten between meals in Korea.

This study was undertaken in an effort to find possible uses for *S. china* leaves as a functional ingredient in the traditional Korean rice cake, *seolgitteok*.

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Materials and Methods

Materials *S. china* leaves were collected from Dalseong-gun, Daegu, Korea in September, 2002. The collected leaves were washed three times with tap water and cut into 1-cm wide pieces. The leaves were kept at 4°C until use. A voucher specimen is kept in the Herbarium of Department of Food and Nutrition, Yeungnam University (Chungmirae leaf 101).

Chemical composition analyses of fresh *S. china* ***Proximate analysis*:** The proximate composition of *S. china* leaves (SL) was determined by the Association of Official Analytical Chemists (13). Moisture and ash content were determined gravimetrically by desiccation at 105°C and incineration at 550°C in a muffle furnace, respectively, and the crude protein content was obtained by the micro-Kjeldahl method. The minerals were analyzed by Inductively Coupled Plasma Mass Spectrometer (Elan 6100; Perkin Elmer, Shelton, CT, USA). Lipids were extracted using a Soxhlet-extraction apparatus, and the content was determined gravimetrically. Fatty acid composition was analyzed with a Hewlett Packard (6890; Palo Alto, CA, USA) gas chromatograph equipped with a flame ionization detector and fused silica capillary column (50 m, 0.25 mm) with 0.20 mm of Carbowax 20M (Quadrex; New Haven, CT, USA). The column temperature was programmed to increase at 10°C/min from 150 to 240°C. The injection port and detector were maintained at 220 and 245°C, respectively. The carrier gas was hydrogen (1.2 mL/min), and the make-up gas was nitrogen (30 mL/min); the split used was 1:100. The fatty acids were identified by comparing the relative retention times of samples with those of standards obtained from Sigma Chemical Co. (St. Louis, MO, USA). The peak areas were determined by the CG-300 computing integrator (CG Instruments, Brazil). Data were calculated as normalized area percentages of fatty acids. For the ascorbic acid assay, fresh leaves were extracted with 5% meta-phosphoric acid, and the extract was analyzed by HPLC (Waters Co., Milford, MA, USA).

Determination of total phenolics and condensed tannin: The Prussian blue method (14) was used to determine total phenolics. A fresh sample (5 g) was extracted with 100 mL of 70% ethanol. The extract was filtered, and the volume was increased 20 times by adding 70% ethanol. To the diluted solution, 3 times of 0.1 M $FeCl_3$ and 0.008 M $K_3Fe(CN)_6$ were added. The mixture was kept at room temperature for 10 min, and the absorbance at 730 nm was measured. A calibration curve was constructed from the absorbance of various dilutions of tannic acid (0.01-0.1 mM; Sigma Chemical Co.). Condensed tannin was analyzed as described by Wang and Hwang (15). Briefly, *S. china* leaves were extracted for 5 min with 70% ethanol using a homogenizer (Hitachi Co., Tokyo, Japan) and then filtered. The vanillin method of Julkunen-Titto (16) was used to determine the amount of condensed tannins. The filtered condensed tannin sample (0.1 mL) was added to 5 mL of 4% vanillin reagent (final volume in methanol containing 4% HCl). Catechin was used as a standard. The pink chromogen that formed was measured at 510 nm and expressed as the catechin equivalent.

Free sugars analysis: The free sugar content was measured according to the method of Chaplin (17). Briefly, fresh leaves were extracted with ten volumes of 80% ethanol for 30 min at 90°C and then filtered. The extract was evaporated to 15 mL, centrifuged for 30 min at 3,000× g and analyzed by HPLC (SP8800; Spectra Physics Co., San Jose, CA, USA).

Amino acids analysis: A sample of fresh leaves was hydrolyzed at 100°C in 6 N HCl solution for 12 hr, concentrated under rotary evaporator and then assayed by automatic amino acid analyzer (L-8800; Hitachi Co., Tokyo, Japan). In this study, the analysis of tryptophan was exclusive. The hydrolysis was carried out at 110°C for 22 hr in a sealed tube under vacuum. Reagents used for the amino acid analysis were purchased from Sigma Chemical Co.

Preparation of rice cakes with added water extract of *S. china* leaves The rice (cultivar, Illmi) was purchased from a local market in Daegu, Korea. One hundred grams of fresh *S. china* leaves were extracted twice in 2 kg of water for 2 hr at 80°C. The extract was filtered and concentrated to 1 kg using a vacuum rotary evaporator (Eyela, Tokyo, Japan). Other materials, including salt (Hanju Salt, Seoul, Korea) and sugar (CJ Co., Seoul, Korea), were purchased from a local market. *Seolgitteok*, the traditional Korean steamed rice cake, was produced according to the method of Yoo *et al.* (18). In preliminary studies, *S. china* leaf extract (SLE) was added at ratios of 0.5, 1.0, 2.0, 4.0, or 8% on the basis of rice flour, and then *seolgitteok*s were manufactured. Based on sensory evaluation, the optimum ratios of leaf extract to flour were determined to be 1 and 2%. The rice was soaked in water for 3 hr at room temperature and drained for 1 hr. The rice was then milled to pass through a 20-mesh sieve, water or SLE was then added to make a thick paste that was mixed with the other ingredients according to the formula shown in Table 1. The mixture was placed in a rectangular stainless steel container (5×12×16 cm) with holes on the bottom and covered with cheese cloth. After being steam-cooked for 1 hr, the mass was cooled to 20°C and cut into 4×4×1 cm portions.

Color measurement The color of the sample was measured with a Colorimeter (CR 300; Minolta, Osaka, Japan) to determine L (lightness), a (redness/greenness), and b (yellowness/blueness) values. The colorimeter was standardized with a white plate (C/2, L= 98.63, a= 0.19, b= -0.67).

Texture analysis The texture of the rice cakes that contained CLE was measured using a rheometer (Compact-100; Sun Scientific Co., Ltd., Tokyo, Japan). Randomly selected whole rice cakes (4×4×1 cm) were placed on two parallels through the center of the rheometer, and force-time curves were recorded. The cross-head speed of the blade was set at 5 cm/min. Peak height was determined as the hardness, cohesiveness, springiness, and brittleness.

Microorganism assay in rice cake The rice cake (1 g) was placed in a sterile Stomacher bag (Seward, London, England) and mixed with 10 mL sterilized water. To determine the total cell count, the following methods were used: For the enumeration of viable aerobic cells in the diluted samples, 100 μL of each sample was spread on plate count agar (PCA) and incubated at 37°C for 24 hr. For the assay of fungi, potato dextrose agar (PDA) was used instead of PCA and plates were incubated at 25°C for 5 days. The units for viable aerobic cells and mold were designated as CFU/g and mycelia/g, respectively.

Sensory evaluation The randomized complete block design was used for sensory evaluations. Eight trained panelists participated in the test, and each panelist tasted 3 freshly

Table 1. Basic formula for *seolgitteok* prepared with the extract of *S. china* leaves

Ingredients \ Sample[1)]	Flour basis[2)] (g)		
	C	SL1	SL2
Rice flour	1000	1000	1000
Water	20	10	0
Sugar	66	66	66
Salt	2	2	2
SL water extract	0	10	20

[1)]C, Control; SL1, *seolgitteok* with 1% of *S. china* leaf extract added on the basis of rice flour; SL2, *seolgitteok* with 2% of *S. china* leaf extract added on the basis of rice flour.
[2)]All ingredient percentages based on rice flour.

prepared samples in a test session. A complete block was executed over two consecutive days, and replications were made. Panelists were allowed to evaluate samples repeatedly and to change their ratings. Distilled water was provided to the panelists for mouth rinsing between samples. The test was carried out in a separated booth area. A seven-point quality scoring test was used to evaluate each different sensory attribute (color, herbal flavor, sweet-savory taste, hard-elastic, intensity, and general acceptability) of the rice cake.

Statistical analysis Data were expressed as mean±standard deviation. Statistical analyses were performed using an SPSS program. One-way ANOVA and Duncan's multiple range tests were used to examine differences between groups. Statistical significance was assigned at p-value <0.05.

Results and Discussion

Interest in physiologically functional foods has increased, and many endeavors to produce functional rice cakes, which contain functional ingredients such as mulberry (6), persimmon (8), and *S. china* leaves (9), have been reported. However, chemical composition analyses of the leaves and quality evaluations of functional rice cakes containing *S. china* leaves, with their various physiological actions, have not been reported. In the present study, we investigated the chemical composition of *S. china* leaves and the quality characteristics of rice cakes prepared with *S. china* leaf extract.

Chemical compositions of *S. china* leaves ***Proximate composition*:** The proximate composition of *S. china leaves* on the basis of fresh weight is presented in Table 2. The crude protein, crude fat, and ash contents of the leaves were 4.90±0.02, 1.20±0.02, and 1.55±0.01%, respectively. The ascorbic acid content was 0.13±0.02% on a fresh weight basis. The protein and ascorbic acid content in these leaves was higher than that of sweet potato leaves, as reported by Ishida *et al.* (19), which contained 3.8 and 0.063 g/100 g, respectively. Total phenolics and condensed tannin contents were 1.26±0.02 and 0.74±0.02%, respectively, on a fresh weight basis, and were higher than those of persimmon leaves collected during the same period (20). Song *et al.* (10) investigated antimicrobial activity and the composition of *S. china* root. They reported that the antimicrobial activity of various solvent fractions obtained from *S. china* root was proportional to the total phenolics content in the solvent fractions. Phenolic compounds exhibit considerable free-radical scavenging and antimicrobial activities, and they are proposed to act as natural food preservatives (21).

***Free sugar and fatty acid*:** The free sugar content of *S. china* leaves is shown in Table 3. Sucrose content was highest in the leaves (0.98±0.02 mg/100 g), followed, in decreasing order, by glucose, fructose, and maltose. Table 4 shows the fatty acid content in *S. china*. Saturated fatty acids were more prevalent than unsaturated fatty acids in *S. china* leaves. In particular, stearic and palmitic acid contents were higher than those of the other fatty acids. On the other hand, the main unsaturated fatty acids in the leaves were linoleic and linolenic acids.

***Amino acid*:** As shown in Table 5, glutamic acid, aspartic acid, and lysine were especially high in these leaves, whereas methionine was lowest in these leaves. The ratios of essential amino acids and non-essential amino acids in *S. china* leaves were 45.3 and 54.7%.

***Mineral*:** The mineral contents of *S. china* leaves are shown in Table 6. Potassium and calcium were the major minerals in the leaves (29.03±0.38 and 13.43±0.31 mg/g, respectively), accounting for 81% of the total mineral content. Therefore, these leaves could be very useful potassium sources. Yoshimura *et al.* (22) described that increasing the K/Na ratio in the diet might be important for the prevention of hypertension and arteriosclerosis. However, potassium in leaves and vegetables is easily lost during cooking in boiling water (23). Therefore, careful consideration and handling are necessary to prevent the effective loss of potassium from these leaves.

Table 4. Fatty acid composition of *S. china* leaves

(mg/100 g, fresh wt)

	Fatty acid	Content
Saturated fatty acid	Lauric acid	27.69±0.34[1)]
	Myristic acid	22.62±0.17
	Palmitic acid	211.73±1.72
	Stearic acid	224.55±3.44
	Total	486.59
Unsaturated fatty acid	Palmitoleic acid	18.66±0.17
	Oleic acid	62.18±0.26
	Linoleic acid	152.31±2.58
	Linolenic acid	140.27±1.72
	Total	373.42

[1)]The values are mean±SD of triplicates.

Table 2. Chemical compositions of *S. china* leaves

(%, fresh wt)

	Moisture	Crude protein	Crude fat	Crude ash	Ascorbic acid	Total phenolic	Condensed tannin
Content	71.73±0.03[1)]	4.90±0.02 (17.3)	1.20±0.02 (4.24)	1.55±0.01 (5.48)	0.13±0.02 (0.45)	1.26±0.02 (4.46)	0.74±0.02 (2.62)

[1)]The values are mean±SD of triplicates. Numerals in parentheses are the values on a dry weight basis.

Table 3. Free sugar contents of *S. china* leaves

(mg/100 g, fresh wt)

	Fructose	Glucose	Sucrose	Maltose	Total
Content	0.12±0.02[1)]	0.63±0.01	0.98±0.02	0.21±0.02	1.94

[1)]The values are mean±SD of triplicates.

Table 5. Amino acid composition of *S. china* leaves

(g/100 g protein)

EAA[1)]	Content	NEAA[2)]	Content
Leucine	8.73±0.05[3)]	Glutamic acid	12.25±0.04
Phenylalanine	7.46±0.04	Aspartic acid	10.56±0.06
Lysine	7.16±0.01	Alanine	6.08±0.03
Valine	6.87±0.04	Arginine	5.69±0.08
Threonine	5.72±0.10	Proline	5.51±0.09
Isoleucine	5.43±0.11	Serine	5.39±0.07
Histidine	3.23±0.06	Glycine	5.23±0.05
Methionine	0.65±0.08	Tyrosine	3.38±0.08
		Cysteine	0.65±0.02
Total	45.25		54.74

[1)]EAA: Essential amino acid, [2)]NEAA: Non-essential amino acid.
[3)]The values are mean±SD of triplicates.

Quality Characteristics of *seolgitteok* prepared with *S. china* leaf extract *Seolgitteok*, a steamed rice cake, generally contains high moisture, is soft and slightly sticky with some elasticity, and is served as a dessert.

Color The Hunter L values of the rice cakes increased significantly with addition of *S. china* leaf extract, whereas Hunter a and b values decreased (Table 7). Similarly, Lee and Jang (12) have also reported that Hunter L values of plain rice cakes increase in proportion to the amount of *S. china* leaf powder added.

Mechanical characteristics Texture is defined as the attributes of a substance resulting from a combination of physical properties, and perceived by the senses of touch, sight, and hearing; the evaluation of a food's texture is driven by mastication (24). Table 8 shows the mechanical characteristics of *seolgitteok* prepared with *S. china* leaf extract. The strength, hardness, cohesiveness, and brittleness of the *seolgitteok* increased as the amount of SLE added to the rice flour increased. However, the springiness of the rice cakes was not influenced by the addition of SLE. In the same way, Lee and Jang (12) reported that the hardness and springiness of plain rice cake prepared with *S. china* leaf powder, as obtained from texture profile analyses, tended to increase with the addition of the leaf powder.

Change of microorganism in *seolgitteok* during storage Table 9 shows changes in microorganism populations during storage of *seolgitteok*s prepared with *S. china* leaf extract at 20°C. At the beginning of the storage period, there were no significant differences in microbial cell counts on PCA and PDA among samples, but significant

Table 6. Mineral content of *S. china* leaves

(mg/g, dry wt)

Minerals	K	Ca	Mg	Fe	Na	Zn	Cu	Mn
Content	29.03±0.38[1)]	13.43±0.31	3.70±0.04	2.93±0.15	1.03±0.15	0.91±0.02	0.80±0.02	0.50±0.02

[1)]The values are mean±SD of triplicates.

Table 7. Hunter color values of *seolgitteoks* prepared with *S. china* leaf extract

Hunter Color Value[2)] \ Sample[1)]	C	SL1	SL 2	F-value
L	61.08±2.53$^{a,3,4)}$	38.35±1.37^{b}	33.40±0.59^{c}	530.336***
a	0.32±0.00^{a}	0.35±0.03^{b}	0.38±0.00^{c}	29.108***
b	0.33±0.00^{a}	0.35±0.01^{b}	0.36±0.00^{c}	2695.236***

[1)]C; Control; SL1, *seolgitteok* with 1% of *S. china* leaf extract added on the basis of rice flour; SL2, *seolgitteok* with 2% of *S. china* leaf extract added on the basis of rice flour.
[2)]L; light scale (100: pure scale, 0; black), a(+red, -green), b(+yellow, -blue).
[3)]The values are mean±SD. *p<0.05, **p<0.01, ***p<0.001.
[4)]The values with different superscripts were significantly different by Duncan's multiple range test (p<0.05).

Table 8. Mechanical characteristics of *seolgitteoks* prepared with *S. china* leaf extract

Samples[1)]	Mechanical properties			
	Hardness (dyne/cm^2)	Cohesiveness (%)	Springiness (%)	Brittleness (g)
C	669,975.8±69,940.4$^{a,2,3)}$	98.0±4.9^{a}	99.6±1.0	173.2±15.0^{a}
SL1	761,317.9±62,258.7^{b}	106.8±11.1^{ab}	99.6±1.2	215.1±28.9^{b}
SL2	872,080.7±36,490.0^{c}	110.6±8.5^{b}	100.4±1.3	253.3±21.9^{c}
F-value	21.299***	3.980*	1.279	21.9***

[1)]C, Control; SL1, *seolgitteok* with 1% of *S. china* leaf extract added on the basis of rice flour; SL2, *seolgitteok* with 2% of *S. china* leaf extract added on the basis of rice flour. The moisture content of samples C, SL1, and SL2 were 43.1±0.52, 41.9±1.03, and 41.5±1.24%, respectively.
[2)]The values are mean±SD. *p<0.05, **p<0.01, ***p<0.001.
[3)]The values with different superscripts were significantly different by Duncan's multiple range test (p<0.05).

Table 9. Changes in microbial cell counts on PCA and PDA of *seolgitteoks* prepared with *S. china* leaf extract during storage at 20°C (cells/g)

Storage days \ Samples[1)]	PCA[2)]			PDA[2)]		
	C	SL1	SL2	C	SL1	SL2
0 day	1.11×10^2	1.31×10^2	1.42×10^2	0	0	0
2 days	4.88×10^2	5.62×10^2	5.01×10^2	0	0	0
4 days	1.65×10^3	1.59×10^3	2.58×10^2	1.31×10^1	1.24×10^1	0
6 days	9.24×10^4	4.01×10^3	4.52×10^3	9.92×10^2	3.45×10^2	8.43×10^1
8 days	3.91×10^6	8.26×10^5	5.83×10^4	5.65×10^4	9.69×10^2	1.54×10^2
10 days	8.27×10^8	9.73×10^6	1.35×10^6	6.34×10^5	5.92×10^3	3.48×10^3

1)C, Control; SL1, *seolgitteok* with 1% of *S. china* leaf extract added on the basis of rice flour; SL2, *seolgitteok* with 2% of *S. china* leaf extract added on the basis of rice flour.
2)The analyses of total cell count and fungi were performed on plate count agar (PCA) and potato dextrose agar (PDA), respectively.

Table 10. Sensory characteristics of *seolgitteoks* prepared with *S. china* leaf extract

Sensory properties		Samples[1)]			F-value
		C	SL1	SL2	
Appearance	Color	3.17±0.70[a, 2,3)]	4.33±0.21[ab]	5.33±0.61[b]	3.848*
	Sleekness	4.17±0.79	3.50±0.56	4.00±0.82	0.224
Flavor	Herb	1.00±0.00[a]	3.00±0.68[ab]	4.00±1.03[b]	4.565*
Taste	Sweet	5.33±0.61[b]	3.33±0.33[a]	3.83±0.54[ab]	4.149*
	Salty	4.00±0.00	3.33±0.49	3.50±0.76	0.436
	Savory	3.00±0.68	3.17±0.60	2.67±0.67	0.153
	Bitter	1.00±0.00[a]	3.83±0.70[b]	6.17±0.48[c]	27.808***
	Herb	1.00±0.00[a]	2.83±0.70[ab]	4.67±0.88[b]	7.926**
Texture	Hardness	4.83±0.79	3.50±0.34	4.00±0.45	1.441
	Chewiness	4.33±0.80	5.00±0.45	4.67±0.67	0.259
	Elasticity	4.50±0.85	5.50±0.72	5.33±0.56	0.558
	Moistness	5.33±0.84	4.14±0.52	4.17±0.79	0.692
	Stickiness	6.17±0.54	5.33±0.61	5.17±0.82	0.738
Acceptability	Appearance	5.00±0.82	5.50±0.56	4.17±0.70	0.921
	Flavor	4.17±0.60[ab]	5.00±0.52[b]	2.67±0.49[a]	8.389*
	Taste	3.67±0.33[b]	4.50±0.34[b]	2.33±0.49[a]	7.588**
	Texture	5.33±0.56	4.50±0.56	4.00±0.73	1.172
	Overall	3.50±0.22[b]	4.33±0.42[b]	1.50±0.34[a]	18.468***

1)C, Control; SL1, *seolgitteok* with 1% of *S. china* leaf extract added on the basis of rice flour; SL2, *seolgitteok* with 2% of *S. china* leaf extract added on the basis of rice flour.
2)The values are mean±SD. * $p<0.05$, ** $p<0.01$, *** $p<0.001$
3)The values with different superscripts were significantly different by Duncan's multiple range test ($p<0.05$).

decreases were observed after four days. After four days of storage, the viable aerobic cell count was 1.65×10^4/g in the control group, but only 9.59×10^2 and 2.58×10^2/g in *seolgitteoks* prepared with 1 and 2% of the leaf extract, respectively. Furthermore, no molds were detected in the 2% extract-added cake after storage for four days. On the other hand, no significant differences were observed between *seolgitteoks* prepared with 1 and 2% of leaf extracts. This result is supported by previous reports that polar solvent fractions obtained from *S. china* leaf showed strong antimicrobial activities against *Listeria monocytogenes* and *Staphylococcus aureus,* Gram (+) bacteria, in an *in vitro* study evaluated by paper disc diffusion method (9). In relation to the antimicrobial activity of *S. china* species, Song *et al.* (10) reported that the main bioactive components exhibiting antimicrobial activity against food spoilage bacteria were phenolic compounds, which were identified using gas chromatography/mass spectra; these phenolic compounds composed 19-46% of fractions obtained from *S. china* root. These results indicate that the addition of *S. china* leaf extract could inhibit microbial growth and extend the shelf-life of the rice cake after production.

Sensory characteristics of *seolgitteok* The sensory characteristics of *seolgitteok* prepared with SLE are summarized in Table 10. In sensory evaluation, the intensity of color, herbal flavor and bitterness were influenced by the amount of SLE added, and these characteristics were highest in *seolgitteok* prepared with 2% SLE on the basis of rice flour. Overall, the hardness of the rice cakes appeared to progressively increase as the amount of SLE increased, whereas moistness and cohesiveness were higher in rice cakes without SLE than in rice cakes with 1 or 2% SLE. However, it should be noted that no significant differences in hardness, moistness, and cohesiveness were observed among any of the samples. In general, appearance, flavor, taste, and overall acceptability were best in *seolgitteok* prepared with 1% SLE.

In conclusion, the chemical composition of *S. china* leaves, used traditionally as a medicinal herb and food material in China and Korea, were analyzed. *S. china* leaves contain large amounts of ascorbic acid, total phenolics, and potassium. Leaf extract was then manufactured, and the quality characteristics of the functional food *seolgitteok*, a traditional Korean rice cake, prepared with *S. china* leaves were evaluated. By mechanical evaluation, texture attributes such as hardness, cohesiveness, springiness, and brittleness increased with the amount of leaf extract added to the rice cake. In sensory evaluation, most favorite quality characteristics were maximized with rice cakes prepared with 1% *S. china* extract. In addition, the total microbial counts show that addition of *S. china* leaf extract to the rice cake extends shelf-life. Further investigations are necessary to isolate the bioactive components of *S. china* leaves, evaluate their physiological properties, and develop diverse functional foods with the leaves.

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