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Physicochemical and Sensory Properties of *Baikseolgi* Made with *Kugija* (*Lycium chinense* Mill.) Powder

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Abstract

***Baikseolgi* was made with *Kugija* powder with the intention to take advantage of its functional properties. Appropriate amount of *Kugija* powder (0~8%) was mixed with rice flour, sugar, salt, and water and then, steamed for predetermined time and their physicochemical and sensory properties were measured. pH decreased significantly while titratable acidity increased significantly with the addition of *Kugija* ($p<0.05$). The addition of *Kugija* powder did not significantly affect the moisture content ($p>0.05$) although it appeared to decrease with the higher amount of *Kugija*. Lightness (L-value) decreased significantly with the addition of *Kugija* ($p<0.05$), indicating that the color of *Baikseolgi* became dark as also indicated by the visual observation. Redness (a-value) and yellowness (b-value), on the other hand, increased significantly as the amount of *Kugija* increased in the sample ($p<0.05$). Both hardness and firmness decreased significantly with the addition of *Kugija* ($p<0.05$). Eight percentage *Kugija Baikseolgi* was significantly stronger in *Kugija* flavor (7.9), chewiness (6.1), sweetness (5.0), and yellowness (8.2) attributes than other samples, whereas control was significantly higher in mouthfeel (6.0) and hardness (6.0) attributes than others ($p<0.05$). Finally, consumer test indicated that 4% *Kugija* sample received the highest score in appearance (8.13) and overall acceptability (8.07) attributes.**

Key words: *Baikseolgi*, physicochemical, sensory, *Kugija* powder, *Lycium chinense* M.

INTRODUCTION

The dried ripe fruit of *Kugija* (*Lycium chinense* Mill.) has been long used in oriental medicine as a tonic (1) and still widely used as food, tea and/or herbal medicine (2). Several volatile steroidal and alkaloidal compounds in this plant are reported to exhibit hypotensive, hypoglycaemic, antipyretic and anti-stress ulcer activity in experimental animals (1). Several investigations were conducted to improve the functional properties of food by adding/mixing this component to produce wet noodle (3), *Kochujang* (4), beer (5), yogurt (6,7), *Injeulmi* (8), Cookie (9), Korean traditional wine (10), and yellow layer cake (11).

Rice cake (*Dduk*) is one of the most important Korean traditional foods and kinds of more than hundreds are available. Among them, *Baikseolgi* is most representative among Korean rice cakes, which is made by steaming the rice flour. The *Baikseolgi* has different kinds of name depending upon what is added. Fruits, vegetable, and even herbal medicine can be added and this makes *Baikseolgi* healthy functional food (12).

Number of researchers have been investigated quality characteristics of *Baikseolgi* made with green tea powder (12), citric acid (13), Hericium erinaceus powder (14), tapioca flour (15), citron preserved in sugar (16), and sea tangle (17). Despite previous investigations, no study has been reported so far on the quality of *Baikseolgi* added with *Kugija* powder. Attempts were made to produce a rice cake having advantages of potentially preventive and therapeutic properties of *Kugija*. The present work aimed at providing reliable experimental data for *Baikseolgi* made with *Kugija* powder and investigating the effects on the physicochemical and sensory properties.

MATERIALS AND METHODS

Preparation of raw material

Prewashed rice (produced in Sangbaek, Gyeongbuk) was soaked in the water for 12 hours and the excessive water was removed by straining for 30 min. The samples were then ground before use. Dried *Kugija* (*Lycium chinense* Mill.; purchased from Jindo, Chunnam) was ground using an analytical mill (model M20, IKA Works, Inc., Wilmington, NC, USA) at maximum speed for 5 min and sieved through a laboratory sieve (40 mesh) and

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a fraction with particles less than 425 μm was used. Salt and sugar were procured from a local market.

Preparation of *Baikseolgi*

Nonglutinous rice powder (350 g) was mixed with 1% salt (3.5 g), 8% water (28 mL) and 12% sugar (42 g) and appropriate amount of *Kugija* powder (0, 2, 4, 6, 8%). The mixture was steamed in a stainless steel steam pan (25×25×15 cm) with 580 mL of water for 20 min at high power, 10 min at low power, and then, 5 min conditioning using a multi-functional oven (model GOR-704C, Tong Yang Magic Corp., Seoul, Korea).

Physicochemical properties evaluation

The pH of *Baikseolgi* was determined by a pH meter (model 340, Mettler Delta Co., Halstead, UK) after mixing each 5 g of *Baikseolgi* sample with 45 mL of distilled water. The same sample was used to measure titratable acidity, amount of 0.1 N NaOH solution to titrate the sample up to pH=8.3. Moisture contents of *Baikseolgi* were measured using a dry oven at 105°C overnight. Texture characteristics were evaluated by 30% compression of individual *Baikseolgi* (3×2×2 cm) with a computer-controlled Advanced Universal Testing System (model LRX*Plus*, Lloyd Instrument Limited, Fareham, Hampshire, UK) at room temperature. A 100-Newton (N) load cell was used, and the crosshead speed was 10 mm/min. A 1.2-cm diameter stainless steel cylinder probe was used. Five samples for each treatment were tested, and their mean values were compared. Color parameters (*L*, *a*, and *b*) of *Baikseolgi* were measured using a Chromameter (model CR-200, Minolta Co., Osaka, Japan) calibrated with a white tile (Y=94.2, x=0.3131, and y=0.3201). All measurements were repeated at least three times.

Sensory evaluation

Baikseolgi made with *Kugija* powder was submitted to sensory assessment by a panel constituted of 10 trained panelists (students majoring in Food Science and Engineering). Attributes evaluated were: *Kugija* flavor, sweet taste, color, texture (hardness and chewiness), and mouthfeel. Panelists expressed judgements about samples using a structured numeric scale of nine points, wherein 9=extremely strong, 8=very much strong, 7=moderately strong, 6=slightly strong, 5=neither strong or weak, 4=slightly weak, 3=moderately weak, 2=very much weak, and 1=extremely weak, for each attribute evaluated. *Baikseolgi* samples wrapped with cheesecloth were cooled down for 20 min at room temperature before they presented to the panelists. Each sample (3×2×2 cm), randomly coded using a three-digit number, was evaluated in each session. Panelists received a tray containing the samples, a glass of water, and an evaluation sheet. The evaluation was done in duplicate.

Consumer test

Each sample was also evaluated by 30 consumer panelists. Five samples were presented in random order as similar to sensory evaluation and were asked to evaluate the consumer attributes of appearance, sweetness, texture, and overall acceptability. A 9-point hedonic scale, wherein 9=like extremely, 8=like very much, 7=like moderately, 6=like slightly, 5=neither like or dislike, 4=dislike slightly, 3=dislike moderately, 2=dislike very much, and 1=dislike extremely, was used. The test was done in duplicate.

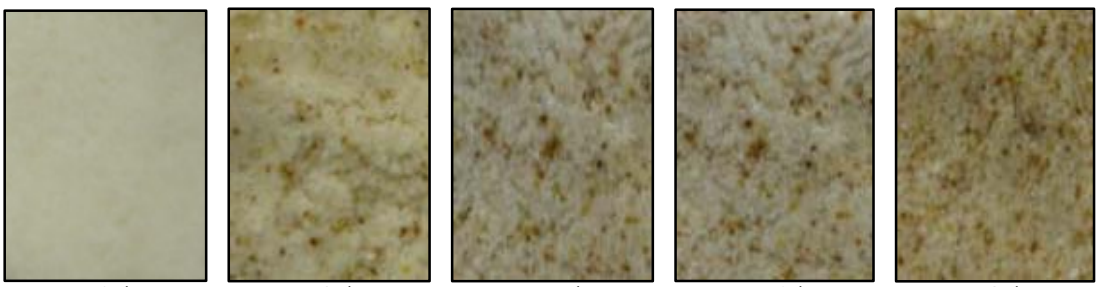
Statistical analysis

The statistical analysis was done using the Statistical Analysis System for Windows v8.1 (SAS Inst. Inc., Cary, N.C., USA). The means were compared with Duncan's Multiple Range test at α=0.05. Regression analyses were also conducted to obtain the prediction equations using the SAS.

RESULTS AND DISCUSSION

Visual observation

Photographs taken for each *Baikseolgi* as affected by the addition of *Kugija* are presented in Fig. 1. Apparently they showed a distinctive color with the addition of *Kugija* and the color became darker with higher amount of *Kugija* in the *Baikseolgi*. In addition, more particles



0% 2% 4% 6% 8%

Fig. 1. Photographs taken for *Baikseolgi* as influenced by *Kugija*.

of *Kugija* are shown on the surface of the sample as the *Kugija* concentration increased.

Physicochemical properties

Changes in pH and titratable acidity of *Baikseolgi* are shown in Figs. 2 and 3, respectively. pH of the control was 6.43 and that of 8% sample was 5.75. pH decreased significantly while titratable acidity increased significantly with the addition of *Kugija* ($p<0.05$). Apparently acidic characteristics of *Kugija* whose pH is 5.17 affected the pH of *Baikseolgi.* Similar findings were reported for mulberry *Baikseolgi* added with citric acid (13) and *Baikseolgi* added with citron (16). Cho and Hong (17), however, reported no significant changes in pH with the addition of up to 35% of sea tangle (whose pH is 6.33) in *Baikseolgi.* The changes in pH and titratable acidity were linear and can be well estimated by the following linear equations:

$$pH = -0.086\ Kugija\ (\%) + 6.386\ (R^2 = 0.9723)$$
$$TA = 0.172\ Kugija\ (\%) + 0.333\ (R^2 = 0.9980)$$

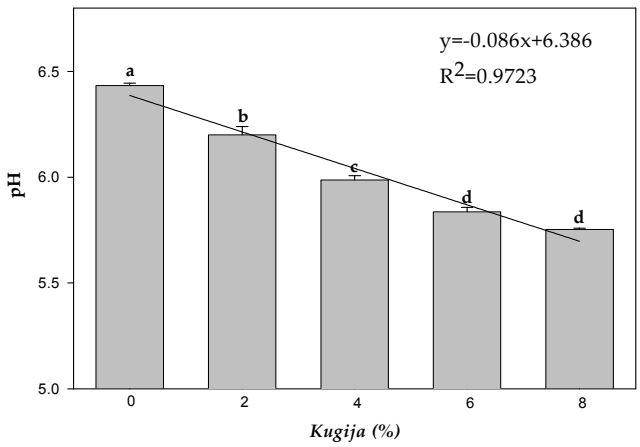


Fig. 2. pH of *Baikseolgi* as influenced by *Kugija*.

Fig. 3. Titratable acidity of *Baikseolgi* as influenced by *Kugija*.

Moisture content and color characteristics of *Baikseolgi* as influenced by *Kugija* are summarized in Table 1. The addition of *Kugija* powder did not significantly affect the moisture content ($p>0.05$) although it appeared to decrease with the higher amount of *Kugija.* Several other researchers reported similar results (13,14,16). However, a significant increase in the moisture content was also reported for the *Baikseolgi* made with sea tangle (17), or waxy sorghum flour (18). This is due to the fact that concentration of added materials was relatively higher, ranged from 30 to 50% as compared to this research, which was up to 8%. Those materials have high amount fiber, which increases water boding capacity.

Lightness (L-value) decreased significantly with the addition of *Kugija* ($p<0.05$), indicating that the color of *Baikseolgi* became dark as also indicated by the visual observation earlier. Redness (a-value), on the other hand, increased significantly as the amount of *Kugija* increased in the sample ($p<0.05$). Similar changes in the lightness and redness were reported (15,16,18,19). Again, yellowness (b-value) significantly increased with increase in *Kugija* content ($p<0.05$). This is due to the natural color of *Kugija,* yellowish red. It appeared that color characteristics of *Kugija* were well carried onto the *Baikseolgi.* This natural color can be easily measured and can be controlled to produce desired sample by changing the amount of *Kugija* added in the sample.

Hardness and firmness of *Baikseolgi* as influenced by *Kugija* are shown in Figs. 4 and 5, respectively. From a typical force-deformation curve, hardness and firmness were derived using the following relationship:

Table 1. Moisture content and color characteristics of *Baikseolgi* as affected by *Kugija*

Property		Concentration of *Kugija*				
		0%	2%	4%	6%	8%
Moisture content		38.33±0.24[a1)]	35.12±4.36[a]	33.83±1.14[a]	34.18±0.54[a]	31.83±0.79[a]
Color	L-value	81.13±1.12[a]	70.05±0.73[b]	69.13±0.80[b]	64.28±0.26[c]	60.59±4.63[c]
	a-value	-3.28±0.02[d]	-0.40±0.21[c]	-0.15±0.02[c]	0.73±0.33[b]	1.29±0.27[a]
	b-value	6.16±0.39[c]	14.27±0.22[b]	15.33±0.40[ab]	15.93±0.43[ab]	16.36±2.23[a]

[1)]Means (±standard deviation) bearing different letters within the same row are significantly different ($p<0.05$).

Fig. 4. Hardness of *Baikseolgi* as influenced by *Kugija*.

Fig. 5. Firmness of *Baikseolgi* as influenced by *Kugija*.

Hardness = Maximum force (N)/Maximum deformation (cm) [=] N/cm

Firmness = Maximum force [=] N

Both hardness and firmness decreased significantly with the addition of *Kugija* ($p<0.05$). Others also reported similar decrease in the hardness with the addition of citric acid (13), sea tangle (17), or persimmon paste (19). Springiness increased while other textural parameters such as gumminess, chewiness, and adhesiveness decreased with the addition of *Kugija* (Table 2). The changes in the hardness and firmness were very much linear and can be readily estimated by the following equations:

Hardness (N/cm) = −0.226 *Kugija* (%) + 4.587 (R^2=0.9934)

Firmness (N) = −0.446 *Kugija* (%) + 4.730 (R^2=0.9998)

Sensory evaluation

The key sensory differences among samples are presented in Table 3 and Fig. 6. The panel's mean scores of each attributes are represented by the points on the chart. The spider chart show that within each sample

Table 3. Sensory properties of *Baikseolgi* as affected by *Kugija*

Attributes	Concentration of *Kugija*				
	0%	2%	4%	6%	8%
Kugija flavor	$1.4^{d1)}$	3.3^{c}	5.1^{b}	7.1^{a}	7.9^{a}
Yellowness	1.3^{e}	3.0^{d}	5.1^{c}	6.6^{b}	8.2^{a}
Sweetness	2.2^{b}	3.4^{ab}	4.1^{a}	4.5^{a}	5.0^{a}
Chewiness	5.4^{a}	4.6^{a}	5.1^{a}	5.5^{a}	6.1^{a}
Hardness	6.0^{a}	5.1^{ab}	4.5^{ab}	3.8^{ab}	3.6^{ab}
Mouthfeel	6.2^{a}	6.0^{a}	5.2^{a}	5.5^{a}	5.2^{a}

[1)]Means bearing different letters within the same row are significantly different ($p<0.05$).

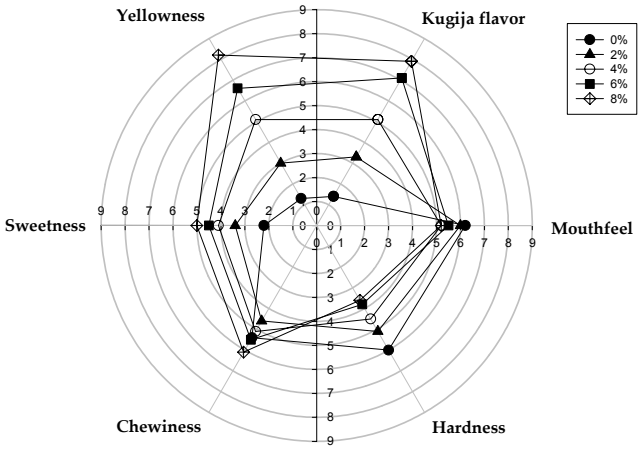


Fig. 6. Spider chart of sensory results of *Baikseolgi* as influenced by *Kugija*.

Table 2. Textural characteristics of *Baikseolgi* as affected by *Kugija*

Characteristics	Concentration of *Kugija*				
	0%	2%	4%	6%	8%
Cohesiveness	$0.38\pm0.03^{a1)}$	0.37 ± 0.02^{a}	0.41 ± 0.03^{a}	0.41 ± 0.04^{a}	0.41 ± 0.03^{a}
Springiness (mm)	6.18 ± 0.31^{b}	6.38 ± 0.33^{b}	6.77 ± 0.268^{a}	6.79 ± 0.13^{a}	6.99 ± 0.27^{a}
Gumminess (N)	1.62 ± 0.29^{a}	1.45 ± 0.23^{ab}	1.43 ± 0.31^{ab}	1.18 ± 0.10^{bc}	1.03 ± 0.18^{c}
Chewiness (N · m)	0.010 ± 0.02^{a}	0.009 ± 0.02^{ab}	0.010 ± 0.02^{ab}	0.008 ± 0.01^{ab}	0.007 ± 0.01^{b}
Adhesiveness (N · mm)	0.27 ± 0.05^{a}	0.11 ± 0.05^{b}	0.05 ± 0.02^{c}	0.00 ± 0.01^{d}	-0.01 ± 0.01^{d}

[1)]Means (±standard deviation) bearing different letters within the same row are significantly different ($p<0.05$).

there were differences in other attributes that made each sample unique. For example, 8% *Kugija Baikseolgi* was significantly stronger in *Kugija* flavor (7.9), chewiness (6.1), sweetness (5.0), and yellowness (8.2) attributes than other samples, whereas control was significantly higher in mouthfeel (6.0) and hardness (6.0) attributes than others ($p<0.05$). In addition, the control showed the lowest scores of *Kugija* flavor, yellowness, and sweetness.

Consumer test

Thirty consumer panelists evaluated 5 samples for the consumer attributes of appearance, sweetness, texture, and overall acceptability. There were significant differences between the samples added with different amounts of *Kugija* powder ($p<0.05$). Eight percent *Kugija* sample received the highest score of sweetness (8.17) as expected, while control received the highest score in texture attribute (7.43). This is due to the fact that *Baikseolgi* became brittle with higher amount of *Kugija* as also indicated from the sensory result as well as mechanical measurements. Nevertheless, 4% *Kugija* sample received the highest score in appearance (8.13) and overall acceptability (8.07) attributes (Table 4, Fig. 7).

Table 4. Consumer test results of *Baikseolgi* as affected by *Kugija*

Attributes	Concentration of *Kugija*				
	0%	2%	4%	6%	8%
Appearance	$4.3^{c1)}$	6.3^{b}	8.1^{a}	6.9^{b}	6.9^{b}
Sweetness	3.6^{d}	5.5^{c}	6.7^{b}	6.8^{b}	8.2^{a}
Texture	7.4^{a}	6.7^{ab}	6.1^{b}	4.3^{c}	3.8^{c}
Overall acceptability	4.0^{c}	6.4^{b}	8.1^{a}	7.1^{b}	4.8^{c}

[1)]Means bearing different letters within the same row are significantly different ($p<0.05$).

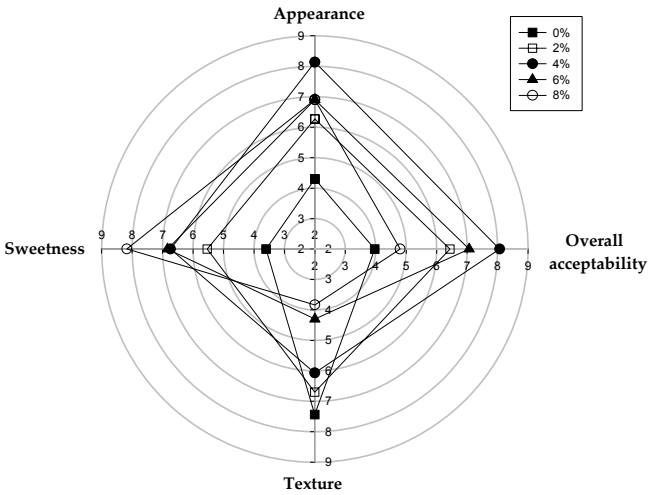


Fig. 7. Spider chart of consumer test results of *Baikseolgi* as influenced by *Kugija*.

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