Physicochemical Characteristics and Antioxidant Capacity of Rice Cake (Sulgitteok) Supplemented with Lyophilized Sedum sarmentosum (Dolnamul) Powder

Seung Mi Kim1, Myung Ho Lee2, Sun A Yang3, Young Sim Choi1, Sung A Jegal1, Chang Keun Sung4, and Eun Kyoung Mo†1

1Research and Development Center, DBIO Incorporation, Daejeon 305-764, Korea
2Department of Hotel Culinary Arts, Shinheung College, Gyeonggi 480-701, Korea
3Department of Food and Culinary Arts, Suwon Women’s College, Gyeonggi 441-748, Korea
4Department of Food Science and Technology, Chungnam National University, Daejeon 305-764, Korea

Abstract

This study was performed to increase the availability of Sedum sarmentosum (Dolnamul) and to improve the nutraceutical value of rice cakes (sulgitteok). The contents of crude protein, mineral, dietary fiber, water holding capacity, and hardness significantly and directly increased with lyophilized sedum powder (SP). Pore ratio and expansion rate decreased in samples containing more than 10% SP compared to the control. In a sensory evaluation, a positive correlation was detected between overall acceptability and taste ($R^2=0.99$, $p<0.01$), and color ($R^2=0.72$, $p<0.05$). Total polyphenol contents of the SP-treated groups were significantly elevated, accompanied by an increase in radical scavenging ability estimated by the 1,1-diphenyl-2-picrylhydrazyl (DPPH) assay. Replacing 10% of the rice powder with SP efficiently improved the antioxidant and nutritional values of sulgitteok as well as its the sensory quality.

Key words: Sedum sarmentosum (Dolnamul), rice cake (sulgitteok), antioxidant, sensory quality

INTRODUCTION

Rice, an essential food resource in Korea, is used for making traditional Korean foods such as rice cakes, alcoholic beverages, and sauces. Various traditional Korean rice cakes (tteok) can be produced, and they are consumed as a celebratory food on special occasions. Generally, tteok are divided into four categories; steamed, pounded, boiled, and pan-fried. Sulgitteok, considered as the most important basic form for other varieties of steamed tteok, is shaped into a single lump and made of rice flour. In order to increase the nutraceutical, physicochemical, and sensory values, and to extend the shelf-life of rice cakes, various subsidiary ingredients are added to sulgitteok (1-3).

Sedum sarmentosum (Dolnamul) is a type of perennial herb consumed as an ingredient in salads and baechu kimchi, a kind of kimchi. In addition, sedum has been used as a folkloric plant in Asia, including Korea and China, for many centuries (4). Unfortunately, the preservation period of sedum is very short due to significant moisture retained and perishable tissues (5). Thus, to increase the availability of sedum, minor efforts have made to produce juices and jellies, although the nutraceutical values have not been reported (6,7).

The consumption of antioxidants leads to a reduction in oxidative stress that can induce the development of human disease, such as cancer and cardiovascular disease (8). Antioxidants derived from vegetables are effective and have reduced interference with the body’s ability to use free radicals (9). Therefore, the use of natural antioxidants present in plant food has attracted considerable interest due to their presumed safety and nutritional value (10).

Recently, sedum extracts have been reported to be comparable to butylated hydroxytoluene (BHT) in antioxidant capacity (11-13). Therefore, this feasible study was performed to improve the nutraceutical value of traditional Korean rice cakes (sulgitteok) with the addition of Dolnamul. Also, we show that Dolnamul is a natural antioxidant source that can be used in the food industry.

MATERIALS AND METHODS

Plant materials and preparation

Fresh Sedum sarmentosum Bunge leaves (general edible portion) were harvested in Seoul, Korea, in January 2009. A voucher specimen (No. DBP-090131) was deposited in the Herbarium at the Research and Development Center of the DBIO Incorporation (Daejeon, Korea).
The sedum was washed and immediately freeze-dried. Lyophilized sedum leaves were powdered and passed through sieves to obtain uniformly sized particles of 0.5 mm.

Production of sulgitteok

Rice (Oryza sativa, Chuchung) was purchased from Nonghyub (Hanaro-mart) in Daejeon, Korea. The rice was washed five times and soaked for 8 hr at room temperature (23 ± 2°C). Milling was performed at commercial facilities (two times), and the sifted powder was used in the production of sulgitteok. The sulgitteok formulas are presented in Table 1. The powdered rice and lyophilized sedum powder were mixed well, and steamed for 20 min. The sulgitteok was used for analysis after cooling for 2 hr at room temperature.

Analyses of general composition

Moisture contents of sulgitteok were determined by a moisture analyzer (MS-70, A&D, Tokyo, Japan). Lyophilized sulgitteoks were ground in a food mixer (HMF-3100S, Hanil electric Co., Seoul, Korea), for analysis of general composition. Crude protein, fat, ash, and dietary fiber were determined by Association of Official Analytical Chemists (AOAC) 984.13A-D, AOAC 920.39A, AOAC 942.05, and AOAC 985.29 standards, respectively (14). Reducing sugar was assessed by the Somogyi-Nelson method (15). For the determination of mineral contents, HNO3 was added to 0.1 g of lyophilized sulgitteok powder in order to decompose organic compounds, and the final volume was adjusted to 100 mL. The concentration of inorganic elements was determined by inductively coupled plasma mass spectrometry (ICP-MS; Optima 4300DU, VG elemental, Perkin Elmer, Norwalk, CT, USA) as previously described (16).

Determination of physicochemical characteristics

Volume, pore ratio, and expansion rate of sulgitteok were assessed as previously reported (16). Twenty mL of distilled water was added to 1 g of sample, mixed for 30 min (25 ± 1°C), and centrifuged for 10 min (900 g); the supernatant was discarded. The water holding capacity (WHC) was obtained by the following equation.

\[ WHC (\%) = \frac{\text{Precipitate (g)} - \text{Sample (g)} \times 100}{\text{Sample (g)}} \]

The chromaticity of sulgitteok (3 × 3 × 3 cm) was measured using a color meter (JX 777, Minolta, Tokyo, Japan), and expressed as Hunter’s L*, a*, and b* color values. The hue angle (h*) and chroma (C*) were calculated as \( h^* = \arctan \frac{b^*}{a^*} \) (deg) and \( C^* = [a^{*2} + b^{*2}]^{1/2} \), respectively.

The textural properties of sulgitteok (3 × 3 × 3 cm) were obtained from the texture profile analysis (TPA) using a Texture Analyser (TA-XT2, Stable Micro Systems, Godalming, Surrey, UK). The operational parameters of the texture analyzer were as follows: pretest speed, 10.0 mm/s; test speed, 5.0 mm/s; posttest speed 10.0 mm/sec; sample area, 3.0 mm²; distance (strain), 90.0%, force threshold, 20.0 g; contact force, 5.0 g; and probe, P10 (10 mm DIA DIA cylinder aluminium).

In order to examine the surface structure of sulgitteok, 5 g of rice cakes was dehydrated by a graded series of ethanol (30, 50, 70, 80, 95, and 100%). The dehydrated samples were dried in a critical-point dryer (BAL-TEC, CPD 030, Los Angeles, CA, USA), and coated with gold in an ion-sputter (Hitachi E-101, Hitachi, Tokyo, Japan). The specimens were examined with a scanning electron microscope (Hitachi S-2350, Hitachi).

Antioxidant activities

One hundred grams of lyophilized and grinded sulgitteok were extracted with 3 L of ethyl acetate at room temperature (20 ± 3°C) for 12 hr. To increase the extraction yield, this procedure was repeated twice. The solvent extracts were concentrated with a rotary vacuum evaporator at 35 ± 1°C. The total polyphenol content (TPC) and antioxidant activities of sulgitteok were measured by DPPH assays as previously described (11). Butylated hydroxytoluene (BHT) was used as a positive control.

Sensory evaluation

A panel of 12 members (6 males and 6 females, ages 20’s to 40’s) evaluated the shape, color (internal and external), flavor, taste, texture, and overall acceptability (the level of preference from the customer’s viewpoint) of the sulgitteok. The samples were presented randomly using a table of sampling digits, and higher point indicated a higher sensory quality (1 to 5 points).

Statistical analysis

All analyses were carried out in triplicate, and the data are expressed as the means ± standard deviation (SD).
One-way analysis of variance (ANOVA) and Duncan’s multiple 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 (ver. 14, SPSS Inc., Chicago, IL, USA).

RESULTS AND DISCUSSION

General composition

The general compositions of sulgitteok prepared with lyophilized sedum powder (SP) are presented in Table 2. The moisture contents slightly decreased in proportion to the SP supplementation, but significant differences were not detected among the samples (p<0.05). The crude protein concentrations of the SP-treated groups were higher than the control group by approximately 15 ~40%. However, the reducing sugar contents slightly decreased in the SP-treated groups, and a significant difference was detected between the control and SS-3.

The crude fat contents of the SP-treated groups were significantly greater compared to the control group. Based on the principle of crude fat determination, components such as pigments and polyphenols could be extracted by diethyl ether. Chlorophylls, carotenoids, and other pigments might be higher in the sedum powder than the rice powder; thus, the crude fat concentrations of the SP-treated groups significantly increased in accordance with the SP supplementation.

The dietary contents were 6.4 g/100 g and 23.11 g/100 g dry weight of rice powder and sedum powder, respectively. Thus, the dietary fiber concentration of sulgitteok significantly increased in proportion to the SP addition.

The ash concentrations of the SP-treated groups were significantly higher than that of the control group, and thus inorganic elemental analysis was performed. Compared to the control group, the contents of calcium, phosphorous, iron, sodium, and potassium were significantly elevated with the increasing SP supplementation. These results indicated that sediment powder substituting for a portion of the rice powder in production of sulgitteok could improve the nutritional value of rice cakes.

Pore ratio and expansion rate

As the amount of SP increased, the pore ratio (PR) and the expansion rate (ER) of sulgitteok increased (Table 3). No significant differences were detected between the control and SS-1 groups, or between SS-1 and SS-2 in PR and ER assessments. Compared to the control group, the PR and ER significantly decreased in SS-3. The images of the surfaces of the sulgitteok are presented in Fig. 1. Pores formed evenly in the control group, but the pore size diminished in SS-3.

Generally, the PR and ER of rice cakes could be increased in conformity with starch gelatinization, and subsequently hindered by the addition of dietary fiber (17).

Table 2. General composition of sulgitteok prepared with various concentrations of lyophilized sedum powder

|            | CO1) | SS-1 | SS-2 | SS-3 |
|------------|------|------|------|------|
| Moisture (%) | 39.77 ± 0.04 | 39.37 ± 0.29 | 39.40 ± 0.46 | 39.71 ± 0.25 |
| Protein (g)2) | 4.96 ± 0.09ab | 5.66 ± 0.18b | 6.55 ± 0.07c | 8.18 ± 0.19d |
| Fat (g) | 2.09 ± 0.04a | 2.19 ± 0.07b | 2.36 ± 0.03c | 2.64 ± 0.06d |
| Ash (g) | 1.01 ± 0.02a | 1.58 ± 0.05b | 2.20 ± 0.02c | 3.40 ± 0.08d |
| Sugar (g) | 67.35 ± 1.28a | 64.93 ± 2.04ab | 64.67 ± 0.71ab | 62.43 ± 1.38ab |
| Dietary fiber (g) | 4.96 ± 0.09a | 5.50 ± 0.17b | 6.23 ± 0.07c | 7.53 ± 0.17d |
| Ca (mg)3) | 9.53 ± 0.18a | 178.31 ± 5.61b | 352.20 ± 3.79c | 696.38 ± 15.44d |
| P (mg) | 71.31 ± 1.35a | 87.26 ± 2.74b | 106.02 ± 1.14c | 141.37 ± 3.13d |
| Fe (mg) | 0.88 ± 0.02a | 2.66 ± 0.08b | 4.52 ± 0.05c | 8.18 ± 0.18d |
| Na (mg) | 11.01 ± 0.21a | 21.46 ± 0.67b | 32.57 ± 0.35c | 54.30 ± 1.20d |
| K (mg) | 204.08 ± 3.88a | 313.36 ± 9.84b | 432.47 ± 4.65c | 663.20 ± 14.70d |

1)Groups are the same as in Table 1.
2)g/100 g of sulgitteok (dry weight).
3)mg/100 g of sulgitteok (dry weight).
4)Different letters in a row denote values that were significantly different (p<0.05).

Table 3. Physical properties of sulgitteok prepared with various concentrations of lyophilized sedum powder (%)

|            | CO1) | SS-1 | SS-2 | SS-3 |
|------------|------|------|------|------|
| Pore ratio | 145.57 ± 12.65ab | 143.75 ± 15.57ab | 128.71 ± 15.65ab |
| Expansion rate | 145.57 ± 12.65ab | 143.75 ± 15.57ab | 128.71 ± 15.65ab |
| Water holding capacity | 37.62 ± 1.11c | 38.27 ± 1.11c | 41.01 ± 1.46c |
Physicochemical Properties of Sedum Sulgitteok

Table 4. Pearson’s correlation coefficients between the sedum powder concentration, water holding capacity, and dietary fiber concentration of sulgitteok prepared with lyophilized sedum powder

|                      | Sedum powder | Water holding capacity | Dietary fiber |
|----------------------|--------------|------------------------|---------------|
| Sedum powder         | 1.000        | 0.993\(^{a}\)         | 0.862\(^{a}\) |
| Water holding capacity| 0.993\(^{a}\) | 1.000                  | 0.836\(^{a}\) |
| Dietary fiber        | 0.862\(^{a}\) | 0.836\(^{a}\)         | 1.000         |

\(^{a}\)Superscript letter means significantly correlated between categories (p < 0.01), analyzed by simple linear regression analysis.

Texture analysis

Previously reported, subsidiary ingredients affect the texture properties of rice cakes (19), and thus the textural characteristics of sulgitteok were determined by texture profile analysis (TPA; Table 5). The hardness of the SP-treated groups was significantly higher than the control. These results suggested that the high hardness values of the SP-treated groups were the result of the low ER of starch (Table 3); however, no significant differences were detected between the control and SS-1, or between SS-2 and SS-3. Gumminess and chewiness were slightly increased in proportion to the SP supplementation, but significant differences were not detected (p=0.185 and p=0.178 for gumminess and chewiness, respectively). Based on the principle of TPA, gumminess and chewiness, calculated from the hardness value, increased with hardness. The springiness and cohesiveness values of the SP-treated groups did not significantly differ from that of the control group (p=0.698 and p=0.899 for springiness and cohesiveness, respectively).

Chromaticity

Compared to the control, the values of lightness (\(L^*\)), greenness (\(a^*\)), and yellowness (\(b^*\)) of the SP-treated groups were significantly changed (Table 6); the lightness values of SP-treated groups decreased by approximately 15% ~ 30%, yellowness declined by approximately 13% ~ 60%, and greenness darkened approximately 9 ~ 18 fold. The yellowness of SS-1 was not significantly different from the control.
Color saturation (C') and tone (h°) were calculated from the color values (Table 6). A hue angle of 90° means ‘yellow’, 150° means ‘green’, and 180° means ‘greenish blue (cyan)’. Despite significant differences between the control and SS-1, the hue angle of SS-1 remained ‘yellow’, but SS-2 and SS-3 exhibited a ‘green’ color tone (20). Thus, the addition of 5% SP to *Sulgitteok* could not change the color tone (h°) of the rice cake to green.

The chroma (C') of SS-2 and SS-3 was significantly lower than that of both the control and SS-1. Chroma describes the vividness or dullness of a color. In spite of no upper limit in chroma, the chroma scale for normal reflecting materials may extend as high as 20, and green colored specimens found in nature, in the range of approximately 8 have vivid color (21,22). Thus, SS-2 and SS-3 were vivid, green-colored *Sulgitteok*.

### TPCs and radical scavenging capacity

Compared to the control, the TPCs of the SP-treated groups were significantly elevated accompanied by an increase in the radical scavenging ability (Table 7). Polyphenol compounds are universally present in plants. Phenolic compounds are regarded as the major phytochemicals responsible for the antioxidant activity in plants (23). A difference in the antioxidant abilities of rice and *S. sarmentosum*, indicates that sedum has a more potent antioxidant capacity (higher TPC) than rice (11,24). Therefore, replacement of rice by SP could be an efficient way to improve the antioxidant value of rice cakes.

### Sensory evaluation

The sensory characteristics of *Sulgitteok* prepared with SP were evaluated by a 12-member panel (Fig. 2). The moisture, flavor, and softness (elasticity) of the SP-treated groups were not significantly different from the control (p=0.198 for moisture, p=0.978 for flavor, and p=0.227 for softness). The control and SS-3 received a significantly higher sensory score than SS-1 and SS-2 in the color category because SS-3 had a vivid, green appearance. Thus, a sufficient amount of a colored subsidiary ingredient should be added to rice cakes to give color, thereby improving the sensory quality of the product. No significant difference was detected between the control and SS-2 in the taste category. SS-1 received a lower sensory score than the both control and SS-2 in taste. The SS-3 received the lowest sensory score because it presented too strong of a sedum taste (slightly bitter). Significant differences in the overall acceptability

### Table 6. Chromaticity of *sulgitteok* prepared with various concentrations of lyophilized sedum powder

|          | CO1 | SS-1 | SS-2 | SS-3 |
|----------|-----|------|------|------|
| Lightness (L°) | 88.96 ± 1.66 | 76.93 ± 0.59 | 75.76 ± 0.48 | 63.97 ± 1.46 |
| Greenness (a°) | -0.32 ± 0.29 | -2.78 ± 1.01 | -4.78 ± 1.32 | -5.65 ± 1.19 |
| Yellowness (b°) | 16.25 ± 1.08 | 14.13 ± 2.43 | 6.65 ± 1.76 | 5.98 ± 1.38 |
| Chroma (C') | 16.26 ± 1.33 | 14.44 ± 1.09 | 8.19 ± 1.86 | 8.24 ± 2.36 |
| Hue angle (h°) | 91.19 ± 1.12 | 101.38 ± 4.98 | 125.39 ± 2.15 | 134.24 ± 4.59 |

1) Groups are the same as in Table 1.
2) Different letters in a row denote values that were significantly different (p<0.05).

### Table 7. Total polyphenol content and radical scavenging capacity of *sulgitteok* prepared with various concentrations of lyophilized sedum powder

|          | CO1 | SS-1 | SS-2 | SS-3 | BHT |
|----------|-----|------|------|------|-----|
| TPC3 | 12.39 ± 2.23 | 46.52 ± 5.15 | 80.65 ± 3.48 | 148.89 ± 9.35 | --   |
| DPPH3 | 518.34 ± 9.54 | 493.39 ± 9.42 | 468.46 ± 6.51 | 418.16 ± 9.67 | 15.78 ± 0.19 |

1) Groups are the same as in Table 1.
2) Different letters in a row denote values that were significantly different (p<0.05).
3) Total polyphenol contents (mg/100 g *Sulgitteok*, dry weight).
4) Radical scavenging capacity (IC50, µg/mL).
were detected among the tested samples in the following order: SS-2>control>SS-1>SS-3. In order to investigate which sensory factors contributed to the overall acceptability, a simple linear regression analysis was performed. A strong, positive correlation was detected between taste and overall acceptability ($R^2=0.99$, $p<0.01$), and between color and overall acceptability ($R^2=0.72$, $p<0.05$). However, moistness, softness (elasticity), and flavor did not contribute to an increase of overall acceptability. Therefore, 10% SP was considered a desirable concentration in order to improve the sensory quality.

**CONCLUSION**

The present study was performed to increase the availability of and to improve the nutraceutical value of rice cakes by the addition of an antioxidant subsidiary ingredient, sedum. Based on the results of this study, the nutritional value and antioxidant capacity of sulgitteok were significantly increased in proportion to increasing SP supplementation. In addition, samples with 10% of added SP had a vivid, green appearance, and attracted the panel’s interests and/or preferences in sensory evaluation. Taking into consideration the decrease in PR and ER, and the increase in hardness in the samples with 20% added SP (SS-3), the substitution of 10% rice powder with the SP in rice cakes could be an efficient method to improve the antioxidant and nutritional values as well as the sensory quality of sulgitteok.

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**REFERENCES**

1. Jung KW, Kim WK, Lee GC. 2011. Effect of different levels of malt extract on antinutrients, in vitro digestibilities and viscosity during fermentation of Jeungpyun. Food Sci Biotechnol 20: 679-685.
2. Lim JH, Park JH. 2011. The quality characteristics of Sulgidduck prepared with parsley powder. Korean J Food Cookery Sci 27: 101-111.
3. Choi BS, Kim HY. 2010. Quality characteristics of Sulgidduk added with perilla leaves. Korean J Cul Res 16: 299-310.
4. He A, Wang M, Hao H, Zhang D, Lee KH. 1998. Hepatoprotective triterpenes form Sedum sarmentosum. Phytchemistry 49: 2607-2610.
5. Kim HJ, Bae JH, Lee SY. 2007. Variation of fresh shoot quality by storage temperature after harvesting in local strain of Sedum sarmentosum. J Bio-Environ Control 16: 240-246.
6. Kim HA, Hong CH, Jeong HS. 2002. Studies of the components in Sedum sarmentosum Bunge as a materials of vegetable health beverage. Culinary Res 8: 55-69.
7. Mo EK, Kim HH, Kim SM, Cho HH, Sung CK. 2007. Production of sedum extract adding jelly and assessment of its physicochemical properties. Korean Food Sci Technol 39: 619-624.
8. Kaliora AC, Dedoussis GVZ, Schmidt H. 2006. Dietary antioxidants in preventing atherogenesis. Athosclerosis 187: 1-17.
9. Wolfe K, Xianzhong WU, Liu RH. 2003. Antioxidant activity of apple peels. J Agric Food Chem 41: 609-614.
10. Ajila CM, Naidu KA, Bhat UIJS, Rao P. 2007. Bioactive compounds and antioxidant potential of mango peel extract. Food Chem 105: 982-988.
11. Mo EK, Kim SM, Yang SA, Oh CJ, Sung CK. 2011. Assessment of antioxidant capacity of sedum (Sedum sarmentosum) as a valuable natural antioxidant source. Food Sci Biotechnol 20: 1061-1067.
12. Heo BG, Park YS, Cho SY, Cho JY, Gorinstein S. 2007. Antioxidant activity and cytotoxicity of methanol extracts from aerial parts of Korean salad plants. Bio Factors 30: 79-89.
13. Kim CY, Lee MY, Park I. 2006. Antioxidant activities of fractions from Sedum sarmentosum. J Food Sci Nutr 11: 6-9.
14. AOAC. 2005. Official Methods of Analysis of AOAC Intl. 18th ed. Association of Official Analytical Communities, Gaithersburg, MD, USA.
15. Nelson NJ. 1944. A photometric adaptation of the Somogyi method for the determination of glucose. J Biol Chem 153: 375-380.
16. Mo EK, Jegal SA, Im DK, Lee MR, Sung CK. 2006. Characteristics and preparation of Jeung-Pyun (Korean fermented rice cake) according to Monascus rubber DSJ-20 as leavening agent. Korean J Food Sci Technol 38: 88-92.
17. Jeon ER, Kim KA, Jung LH. 2002. Effects of Sikhe dietary fibers on the rice starch gelatinization and retrogradation properties. Korean J Soc Food Cookery Sci 18: 157-163.
18. Shin EH, Lee JK. 2004. Quality characteristics of Jeung-Pyun on the addition ratio of pigmented rice and fermented methods. Korean J Food Cookery Sci 20: 380-386.
19. Lee KS, Lee JC, Lee JK, Park WJ. 2001. Effect of addition of minor ingredients for the quality characteristics of Sulgiduk. Korean J Dietary Culture 16: 399-406.
20. Wrolstad RE, Dursta RW, Lee J. 2005. Tracking color and pigment changes in anthocyanin products. Trends Food Sci Technol 16: 423-428.
21. Conway BR, Tsao DY. 2009. Color-tuned neurons are spatially clustered according to color preference within alert macaque posterior inferior temporal cortex. Proc Natl Acad Sci U S A. 106: 18034-18039.
22. Landa ER, Fairchild MD. 2005. Charting color from the eye of the beholder. American Scientist 93: 436-443.
23. Arabashahi-Delouee S, Urooj A. 2007. Antioxidant properties of various solvent extracts of mulberry (Morus indicus L) leaves. Food Chem 102: 1233-1240.
24. Chi HY, Lee CH, Kim KH. 2007. Analysis of phenolic compounds and antioxidant activity with H4IE cells of three different rice grain varieties. Eur Food Res Technol 225: 887-893.

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