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Rutin, Catechin Derivatives, and Chemical Components of Tartary Buckwheat (*Fagopyrum tataricum* Gaertn.) Sprouts

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ABSTRACT The aim of this study was to develop the tartary buckwheat (*Fagopyrum tataricum* Gaertn.) sprouts and to clarify the biological and chemical characteristics of the sprouts. At 7 days after seeding, hypocotyls length and thickness, and root length of tartary buckwheat sprouts were 13.7 cm, 1.4 mm, and 12.6 cm, respectively. Fresh weight, dry weight, and moisture contents of an individual sprout at 7 days after seeding were 202 mg, 5.4 mg, and 95.3%, respectively. Protein content in tartary buckwheat sprouts was 23.0% which relatively higher than that of seeds, while lipid and ash contents were 3.5% and 5.3%. Among 7 minerals, the content of phosphorus showed the highest level (1,383.5 mg/100 g), while the contents of sodium and potassium were 1,197.5 mg/100 g and 1,106 mg/100 g, respectively. The contents of other minerals were Mg (795.5 mg/100 g), Ca (149 mg/100 g), Zn (16.4 mg/100 g), and Fe (14.7 mg/100 g). The rutin content of tatary buckwheat sprouts including root parts was the highest (5644.9 mg/100 g) at 7 days after seeding. The concentration of catechin derivatives in tartary buckwheat sprouts was high in order of catechin (59 mg/100 g), epicatechin gallate (47 mg/100 g), and epicatechin (14 mg/100 g).

Keywords : tartary buckwheat (*Fagopyrum tataricum* Gaertn.), sprouts, rutin, catechin, nutritive value

Buckwheat has been used both as a food and a traditional medicine (Marshall & Pomeranz, 1983; Xiaoling *et al.*, 1992). Buckwheat grown in Korea is used largely for noodles, curds, and various purposes (Choi *et al.*, 1996).

Since the sprout of common buckwheat (Fagopyrum esculentum Moench) was developed in Korea (Kim *et al.*, 1998, 2001, 2004), consumption and market for buckwheat sprouts have been growing and also processing products with buckwheat sprouts are recently provided to the domestic market. Buckwheat sprouts have a soft and slightly crispy texture and an attractive fragrance, but do not have a beany flavor as soybean sprouts do. Buckwheat sprouts are abundant in amino acids, minerals, and crude fiber. It was noted that lysine content in buckwheat sprouts was considerably higher than those of buckwheat seeds and other cereals. Moreover the rutin content in buckwheat sprouts was higher than those of buckwheat seeds. Buckwheat sprouts are mainly used as a fresh vegetable, seasonings, and fresh juice. The powder of buckwheat sprout made by drying and subsequent milling is being used for the soft and health food stuffs such as soup, drink, and tea for people who care health and patients as well.

Buckwheat sprouts are known to contain high rutin and catechin derivatives and have a potential of high antioxidant activity and other protective effects of the geriatric disease (Park & Choi, 2004; Park *et al.*, 2005). Therefore, they have been recommended as a good vegetable for preventing obesity, high blood pressure, and diabetes (Park & Choi, 2004).

Tartary buckwheat (*Fagopyrum tataricum* Gaertn.) is a native species to Himalayan regions. It is being cultivated as a major crop and used as a staple food in the regions. Recently, interest in tartary buckwheat is growing even though the species has not been cultivated in Korea. Tartary buckwheat was found to have high flavonoids (Park *et al.*, 2005), and it's sprouts are also expected to be

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more useful for human health. The aim of this study is to develop the production process for tartary buckwheat sprouts and to clarify the biological and chemical characteristics of the sprouts.

MATERIALS AND METHODS

Seeds of tartary buckwheat (line KW45 introduced from Japan) were soaked into water for 24 hours and washed several times with tap water. The 400 g of washed seed was put on the steel net (47.5 cm × 27.3 cm) of seeding tray which was specially devised for buckwheat sprouts, and kept in dark condition for 24 hours with a growth chamber at 25℃. Watering was done by sprinkler for 6 times a day. The morphological characteristics of the sprouts were daily investigated for hypocotyl length, shape and color of cotyledon, fresh weight, dry weight, and moisture contents.

Protein content was determined in triplicate using an adaptation of the AOAC official method (AOAC, 1995). A conversion factor of 6.25 was used to calculate protein from nitrogen contents. Oil content was measured by Soxtherm automatic system (Gerhardt, Hoffmannstre, Germany). The 5.0 g of homogenized sample was put into extraction thimble and add 140 mL of *n*-hexane. After boiling for 30 min at 180℃, extraction was performed for 80 min with 5 times of solvent reduction. Total oil contents were represented on a dry basis.

Mineral content was determined in triplicate according to AACC method 08-01 (AACC, 2000). Rutin contents in tatary buckwheat sprouts were analyzed according to days after seeding and catechins were analyzed with 7 days-old sprouts. Analysis of rutin and catechins was performed on a Waters 2690 separation module equipped with a photodiode array detection system Waters 996 (Waters Milford, USA). The column used was an XTerra MS C_{18}, 5 ㎛ (150×2.1 mm, Waters), and operated at the temperature of 25℃. The mobile phase consisted of 2% acetic acid in water (eluent A) and of 0.5% acetic acid in water and acetonitrile (eluent B). The gradient program was as follows : 10% B to 55% B (50 min), 55% B to 100% B (10 min), 100% B to 10% B (5 min). The injection volume for all samples was 2 ㎕. Spectra were recorded from 200 to 450 nm at a flow-rate of 0.2 mL min^{-1}. Rutin, (-)epicatechin, (+)catechin, (-)epicatechingallate were obtained from Sigma (St. Louis, USA).

RESULTS AND DISCUSSION

Production of tartary buckwheat sprouts

Pericarp was removed from seeds when the sprouts come up through the upper steel net of seeding tray. Tartary buckwheat sprouts consist of yellow-colored cotyledon, milky white-colored hypocotyls, and brown-colored roots, which looked like common buckwheat sprouts in their appearances. Some of sprouts have occasionally pink-colored in the upper parts of hypocotyls and partially pink-colored cotyledon (Fig. 1).

Tartary buckwheat sprouts were classified into three groups : (A) normal sprouts grown fully in the seeding tray, (B) mixture of not-germinated seeds, removed-pericarps from seeds, and poorly grown sprouts in downward of seeding tray, (C) roots and residues remained on the steel net of seeding tray.

Hypocotyls length and thickness of tartary buckwheat sprouts showed the highest at 6 days after seeding (Table 1). Root length was increased approximately 3.5 cm in a day from 4 days after germination. At 7 days after seeding,

Fig. 1. Tartary buckwheat sprouts at 7 days after seeding.

Table 1. Root length, hypocotyl length and thickness of tartary buckwheat sprouts.

Days after germination	Hypocotyl length (cm)	Hypocotyl thickness (mm)	Root length (cm)
3	1.78±0.26	1.42±0.10	2.10±0.24
4	3.28±0.28	1.50±0.08	5.60±0.92
5	6.16±0.72	1.50±0.08	7.63±1.03
6	9.47±0.95	1.50±0.07	10.45±0.40
7	10.76±1.74	1.32±0.10	10.76±1.52
8	12.16±1.75	1.30±0.13	11.18±1.41
9	13.69±1.24	1.39±0.09	12.59±1.37

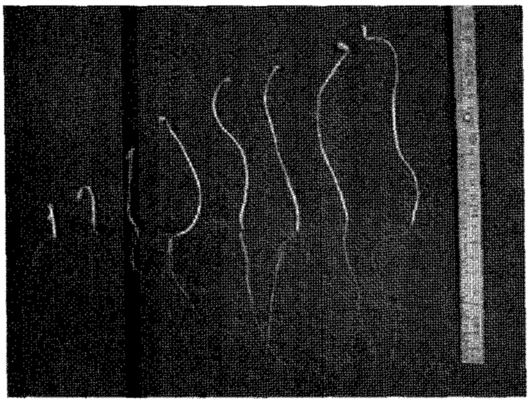

Fig. 2. Growth shape of tartary buckwheat sprouts from 2 to 9 days after seeding.

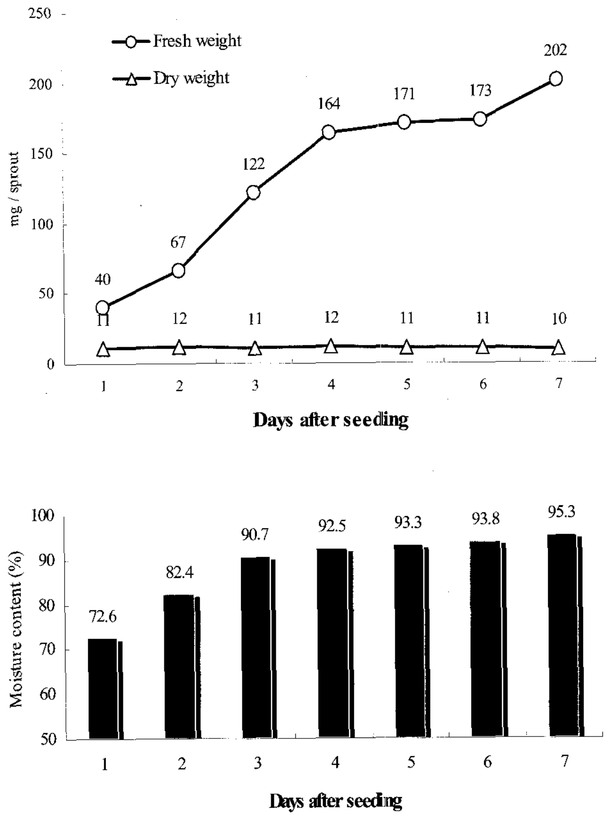

Fig. 3. Daily changes in fresh weight, dry weight, and moisture content (from upper) of tartarysprouts.

hypocotyls length, hypocotyls thickness, and root length were 13.7 cm, 1.4 mm, and 12.6 cm, respectively. These results were slightly different from common buckwheat sprouts showing hypocotyl length of 16cm and hypocotyl thickness of 0.85 mm (Kim *et al.*, 1998).

Fresh weight, dry weight, and moisture contents of an individual tartary buckwheat sprout at 7 day after seeding were 202 mg, 5.4 mg, and 95.3%, respectively.

In spite of the highest fresh weight of 7 days-old sprouts, their lower dry weight indicated the relatively high rate of moisture contents. Therefore, daily increase of fresh weight was attributed to the increase of moisture contents (Fig. 3). At 7 days after seeding, fresh weight of normal sprouts without roots (A) in the seeding tray was 428 g, while that of others (B and C) was 738 g. Total fresh weight (A, B, and C) and dry weight were 1194 g and 240 g, respectively. The tartary buckwheat seeds increased to 3 times on the fresh weight basis. The yield of normal sprouts was approximately one third of total fresh weight. However, the yield of abnormal sprouts, removed-pericarps, roots, and not-germinated seeds was approximately amounted to two third of total fresh weight. The 400 g of buckwheat seeds were counted up 26,333 seeds and the fresh weight of individual tatary buckwheat sprout was about 202 mg in average. Theoretically, the 5319 g of buckwheat sprouts could be produced from the 400 g of tartary buckwheat seeds if all seeds are assumed to be germinated completely. However, the actual yield of tatary buckwheat sprouts showed a very low level as compared to the theoretical yield and the previous report (Kim *et al.*, 1998). From the results, it was considered that the production technology should be improved for higher yield of tartary buckwheat sprouts. It includes the improvement in factors affecting seed quality such as germination rates and seedling growth. The rate of normal sprouts growing upward the 2nd layer steel net should be also increased by improving the seeding tray. New cultivation system that provides the higher yield of tatary buckwheat sprouts was developed during the process of this study (unpublished).

Chemical components in tartary buckwheat sprouts

Chemical components in tartary buckwheat sprouts are shown in Table 2.

Protein content in tartary buckwheat sprouts was 23% which relatively higher than that of seeds, while lipid and ash contents were 3.5% and 5.3%, respectively. Among 7 minerals, the content of phosphorus (P) showed the highest level (1,383.5 mg/100 g), while sodium (Na) and potassium (K) were 1,197.5 mg/100 g, 1,106 mg/100 g, respectively. These levels are relatively higher than those of daily recommended amount for adult. The concentration of other minerals was Mg (795.5 mg), Ca (149 mg), Zn (16.4 mg), and Fe (14.7 mg). Comparing to mineral contents in common buckwheat sprouts (Kim *et al.*, 1998), tartatry buckwheat sprouts was shown to be 7 times lower in Ca but 9 times higher in Mg.

Kim *et al.* (1998) reported that rutin contents in common buckwheat sprouts were increased until 8 days after germination and decreased as seeding days progressed. However, the changes of rutin content in tatary buckwheat sprouts did not show any regular trend during germination (Fig. 4). The highest rutin content was found in the 7-days old sprouts (5225.7 mg/100 g). Rutin contents in the whole sprouts including hypocotyls and roots showed their highest level (5644.9 mg/100 g) at 7 days after seeding, while the roots of 6 day-old sprouts showed the highest rutin content (473.3 mg/100 g). However, rutin content of the mixture of abnormal sprouts, removed-pericarps, not-germinated seeds, roots, and residues was varied from 256 mg/100 g to 1597 mg/100 g according to days after seeding. Therefore, we suggested that poorly grown sprouts and residues would be better to use in form of refined powder by drying and milling for the purpose of enhancing the additional values of tartary buckwheat sprouts.

Table 2. Protein, lipid, ash, and mineral contents in the 7-days old tartary buckwheat sprouts.

Protein (%)	Lipid (%)	Ash (%)	Minerals (mg/100 g, DW)						
			Ca	P	Fe	Na	K	Zn	Mg
23.0	3.5	5.3	149.0	1383.5	14.7	1197.5	1106.0	16.4	795.5

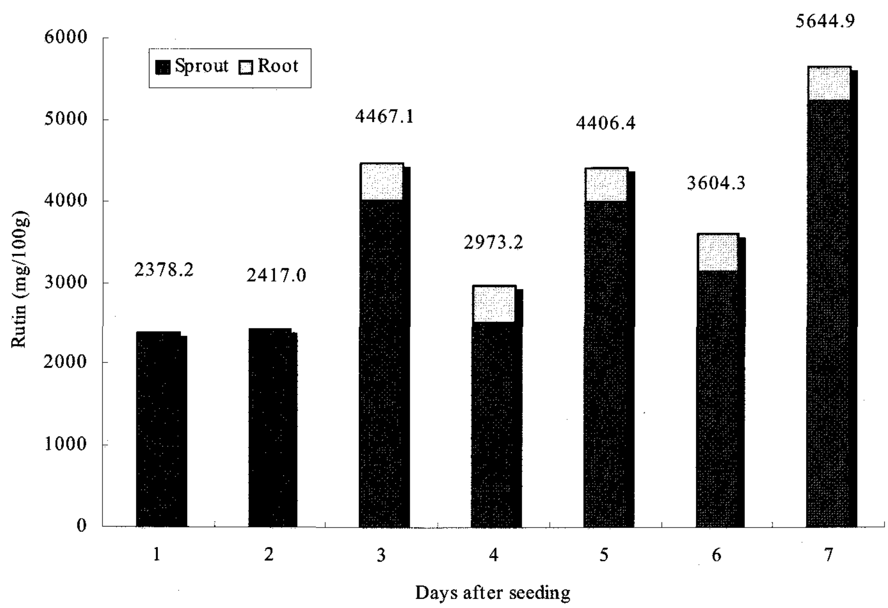

Fig. 4. Changes of rutin contents in tartarysprout as seeding days progressed.

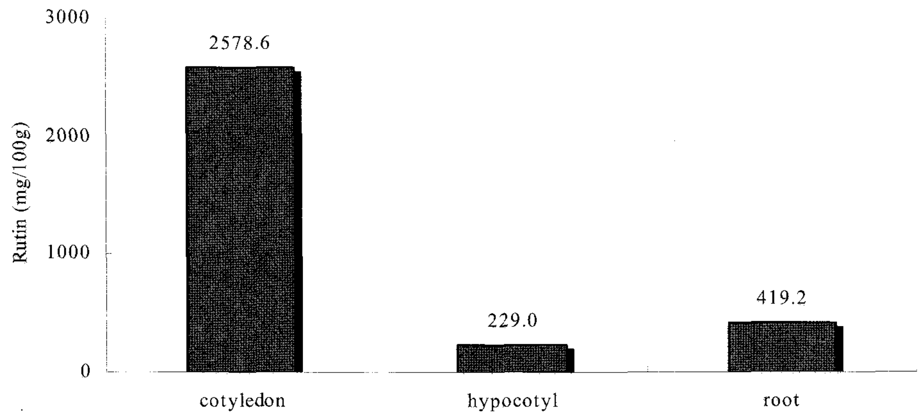

Fig. 5. Rutin contents in cotyledon, hypocotyl, and root of tartary buckwheat sprouts.

Table 3. Comparison on catechin derivatives contents between the sprouts of different buckwheat species.

Buckwheat sprouts	Catechin	Epicatechin	Epicatechin gallate
	mg/100 g		
Common buckwheat	55.8±5.1	16.5±1.1	30.1±3.3
Tartary buckwheat	59.4±7.5	13.9±2.2	47.1±2.9
LSD (0.05)	ns*	ns	8.3

*not significant

Buckwheat is cited as an origin plant of rutin (Couch *et al.*, 1946) which is a kind of flavonol glycoside compounds used in preventing edema, haemorrhagic diseases, and stabilizing high blood pressure due to its effectiveness in controlling blood vessel (Havesteen, 1983; Xialoling *et al.*, 1992).

Rutin and catechin derivatives contents were analyzed based on parts of the 7 days-old sprouts. As shown in Fig. 5, rutin contents were high in order of cotyledon (2,578.6 mg/100 g), roots (419.20 mg/100 g), and hypocotyls (229.04 mg/100 g). This result indicates that a major source of rutin is cotyledon rather than other parts of sprouts.

The concentration of catechin derivatives in tartary buckwheat sprouts was high in order of catechin (59 mg/100 g), epicatechin gallate (47 mg/g), and epicatechin (14 mg/g). However, there was no significantly differences in catechin derivatives between buckwheat species besides epicatechin gallate.

Tartary buckwheat sprouts produced by water culture system were found to have a good nutritive value and high contents of rutin and catechin derivatives. They have also benefits to cook easily and are able to be applied to the production of diverse processing products. It does not have doubt that they are expected to contribute to tartary buckwheat industry which is at the early stage in Korea.

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