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Original Article

Nutritional and nutraceutical characteristics of *Sageretia theezans* fruit

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ABSTRACT

The fruit of *Sageretia theezans* is one of many underutilized edible fruits that grow along the southern seashores of East Asia. In this study, to evaluate the nutritional and nutraceutical values of *S. theezans* fruit, the composition of minerals, organic acids, and proximate and fatty acids, the total phenolic, total flavonoid, and total anthocyanin content, and the antioxidant and antidiabetic activities of *S. theezans* fruit were analyzed. The results indicate that *S. theezans* fruit could be classified as a potential potassium-, malic acid-, and linoleic/oleic acid-rich fruit. In addition, The ethyl acetate (EtOAc) fraction of the 70% ethanol (EtOH) crude extract exhibited strong antioxidant activities including free radical scavenging and reducing power activities compared with the same concentration of butylated hydroxytoluene. Furthermore, the EtOAc fraction showed significant inhibition of α-glucosidase activity. The analysis of the total phenolic and flavonoid content suggested that the remarkable antioxidant and antidiabetic activities of the EtOAc fraction are due to the presence of high levels of polyphenolic compounds.

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1. Introduction

Sageretia theezans, commonly known as Chinese sweet plum, alternatively named Chinese bird plum, is an evergreen tender shrub of the Rhamnaceae family [1]. Although *S. theezans* is widely used to create bonsais, it has been used in traditional herbal medicine for the treatment of hepatitis and fevers in Korea and China [1–3]. Since friedeline, syringic acid, beta-sitosterol, daucosterol, gluco-syringic acid, and taraxerol were isolated from *S. theezans* [4], flavonol glycosides from leaves, named 7-O-methylmearnsitrin, myricetrin, kaempferol 3-O-R-L-rhamnopyranoside, europetin 3-O-R-L-rhamnoside, and 7-O-methyl quercetin 3-O-R-L-rhamnopyranoside, have been isolated [1]. Based on the *in vitro* analysis of free radical scavenging activity, myricetrin and 7-O-methylmearnsitrin have shown stronger antioxidant activities than ascorbic acid and α-tocopherol [1]. In addition, flavonoid-rich fractions from *S. theezans* leaves exhibited a protective effect on low-density lipoprotein against oxidative modification [1]. This indicates the considerable potential of *S. theezans* as a resource for functional applications in the cosmetic and pharmaceutical industries.

In developing countries, numerous types of edible wild plants are exploited as sources of supplementary nutrition including carbohydrates, protein, fat, vitamins, and minerals [5]. The Food and Agricultural Organization reported that at least one billion people are thought to use wild food in their diet [6,7]. In the past decades, numerous studies have demonstrated the value of wild fruits to provide nutritional and medicinal needs and suggested that the kinds and amounts of minerals, organic acids, and dietary fibers they include are important factors for determining whether wild fruits and vegetables are potential sources for dietary health supplements [8]. In addition, the World Health Organization emphasizes that the antioxidant activity of phenolic compounds from small colorful fruits plays an important role in the protection of cellular compounds such as lipids, membranes, proteins, and nucleic acids from oxidative damage, resulting in preventing many health problems, such as, cancer, diabetes, cardiovascular diseases, and obesity [9,10]. In the case of *S. theezans*, the fruit is hexose-dominated (glucose, 12.7% of pulp dry weight; fructose, 11.8% of pulp dry weight [11]), and a flavonoid-rich fraction of leaves has been suggested as a candidate material for use in functional foods and dietary supplements [1]. Although the fruit is known to be edible, the nutritional information for the raw fruit is unavailable.

Therefore, in this study, we evaluate the nutritional value of *S. theezans* fruit by analyzing its minerals, organic acids, proximate composition, and fatty acid content. In addition, the pharmaceutical properties of the fruit such as its antioxidant and antidiabetic activities were determined. These results will help consumers and researchers to make it a regular source of food and a dietary health supplement.

2. Methods

2.1. Plant materials

S. theezans fruits were collected in Jeju Island, Republic of Korea, in May 2012. The collected samples were washed under running tap water and rinsed in distilled water. Fresh or freeze dried samples were used for experiments.

2.2. The measurement of pH, total soluble solids, and total acidity

The pH and total soluble solids (in degrees Brix) of the juice of *S. theezans* fruits were determined using a pH meter (Metrohm-827, Metrohm AG, Herisau, Switzerland) and a refractometer (PAL-1, Atago, Tokyo, Japan).

The total acidity of the juice was determined using a titration method; 10 mL of the diluted juice (10% solution of the sample) was titrated against 0.05 N of NaOH using a phenolphthalein indicator. The end point was noted (the color changed from colorless to pale pink). The results were expressed as a percentage of malic acid according to AOAC [12].

2.3. Proximate analysis

The moisture content was determined after drying the sample at 105°C until a constant weight was attained, calculated as the loss in weight of the original sample and expressed as the percentage of moisture content [12]. The crude protein was determined by the macro-Kjeldahl method [12]. The percent protein was calculated by multiplying the percent nitrogen by the conversion factor 6.25. Crude lipids were extracted using the Soxhlet extraction method, and the ash content was determined according to methods outlined in AOAC [12]. Crude fiber was estimated by acid-base digestion with H_2SO_4 (1.25%) and NaOH (1.25%) solution as described by Association of Analytical Chemists International (AOAC) [12].

2.4. Mineral composition

S. theezans fruits (freeze dried materials) were digested with H_2SO_4 and H_2O_2. Then, their mineral composition (e.g., K, Ca, Mg, Na, Mn, Fe, P, Mo, B, and Cu) was determined by inductively-coupled argon plasma optical emission spectrometry, using a Perkin-Elmer Optima 7300 DV system (PerkinElmer, Waltham, MA, USA).

2.5. The analysis of organic acids

First, 1 g of the freeze dried sample was mixed with 100 mL of distilled water. After centrifugation at 6500 g for 10 minutes, the supernatant was diluted with ultra-pure water. The diluted sample was loaded on a Sep-Pack C18 cartridge (Waters Millipore, Milford, MA, USA) and then filtered through a 0.2 μm membrane filter. To determine the concentration of organic acids including oxalic acid, tartaric acid, malic acid, lactic acid, citric acid, and succinic acid, a Grace prevail organic acid column (150 mm × 46 mm, 3 μm) was applied, with 0.5mM of KH_2PO_4 serving as the mobile phase at a flow rate of 0.5 mL/min. The high-performance liquid chromatography-photodiode array apparatus consisted of a Waters Alliance 2695 separations module and a Waters 2996 photodiode array detector with Empower 2 software for data acquisition (Waters Millipore). The standard calibration curves of organic acids were constructed in the concentration