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CHEMICAL COMPOSITION AND ANTIOXIDANT ACTIVITY OF *Saussurea involucrata* SEED[a]

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Saussurea involucrata Kar. et Kir. (snow lotus) is an endangered and rare plant, which belongs to the family Asteraceae. The snow lotus, as traditional folk medicine, has been used in the treatment of rheumatic arthritis, gynopathy, stomachache, and altitude sickness [1–3]. It was found that this plant had anti-inflammatory, cardiotonic, abortifacient, anticancer, and antifatigue effects [4–6]. In addition, coumarins, flavonoids, guaianolides, and sesquiterpene lactones have been reported from the snow lotus [7–9]. However, no study on the chemical composition and antioxidant activity of snow lotus seed has been reported so far.

Snow lotus seed was collected from Tianshan Mountain in Xinjiang. The snow lotus seed was extracted with hexane by a Soxhlet extractor for 4 h. The yield of snow lotus seed oil was 15.43%. Fatty acid compositions of the oil were analyzed by GC and GC-MS in methyl ester form by the method [3]. GC and GC-MS of fatty acids were performed on a Hewlett- Packard 6890 GC with a FID detector and on a Shimadzu GC2010 GC with a Shimadzu QP2010MS mass selective detector. An apolar Rtx-5MS capillary column (30 m $\times$ 0.25 mm $\times$ 0.25 μm) was used in both equipments. Column temperature was at 160°C, held for 2 min, raised to 260°C at a rate of 6°C/min, and held for 5 min. Nitrogen was used as the carrier gas, at a flow rate of 1.02 mL/min. The obtained results are presented in Table 1. The main fatty acid compositions in the oil were as follows: 18:2n-6 (59.89%), 18:1n-9 (21.38%), 16:0 (8.98%), and 18:3n-6 (5.20%). The amounts of saturated and unsaturated fatty acid in the oil were found to be 11.68% and 88.32%, respectively.

About 1.0 g dried sample was incinerated in a MARS 5 microwave oven with pure HNO_3. Nineteen kinds of element concentrations were determined in a sample by inductively coupled plasma atomic emission spectrometry (ICP-AES, Varian-Vista). Three replications of incineration were made. The results obtained are shown in Table 2. From this table, we can see that the seed is rich in Na, Ca, K, Mg, S, and P. The concentrations of harmful elements in snow lotus seed such as Cd and As, were very low.

A lower IC_{50} value indicates higher antioxidant activity. According to various polar solvent extracts, the antioxidant properties are considered to be different. Therefore we studied the antioxidant activity both in methanol and in hexane. DPPH radical-scavenging effects of the extracts were estimated by the method [10]. Snow lotus methanol extract (SLME) showed higher scavenging activity (0.16 mg/mL) on DPPH radicals compared with hexane extract (SLHE) activity (16.58 mg/mL). This assay was carried out according to the procedure [11]. Both SLME and SLHE exhibit good ABTS radical-scavenging activity. The ABTS IC_{50} values of SLME and SLHE were 0.94 and 8.56 mg/mL, respectively. The reducing power of the extracts was determined by the method [12]. In the reducing power test, increased absorbance of the reaction mixture indicates increased reducing power. As shown in Fig. 1, both extracts had some degree of electron donation capacity in a concentration-dependent manner.

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TABLE 1. Fatty Acid Compositions of *Saussurea involucrata* Seed

Compound	Retention time, min	Relative content, %	Compound	Retention time, min	Relative content, %
16:0	12.99	8.98	20:0	19.73	0.52
18:2 n-6	16.15	59.89	22:0	22.72	0.29
18:1 n-9	16.22	21.38	Σ_{SFA}		11.68
18:0	16.56	1.89	Σ_{UFA}		88.32
18:3 n-3	18.77	1.84	Total		100.00
18:3 n-6	19.26	5.20			

TABLE 2. Elemental Contents of *Saussurea involucrata* Seed

Element	Value, mg/kg	Element	Value, mg/kg
B	23.39	As	1.70
Ba	3.36	Ca	5074.45
Cd	0.50	Fe	247.02
Na	732.40	K	14148.46
Pd	5.95	Mg	4326.47
Se	1.29	Mn	24.22
Cr	1.11	Ni	4.93
Cu	22.14	Zn	30.15
Mo	1.30	P	4209.77
Ti	4.01	S	2270.28
Al	294.44		

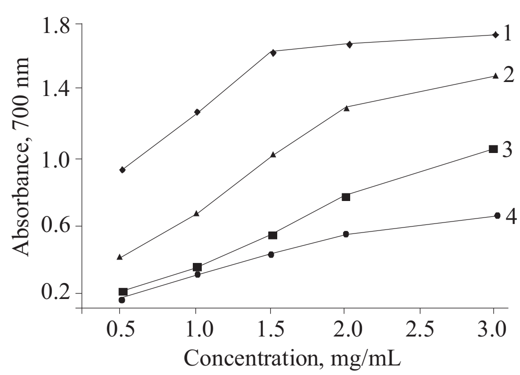

Fig. 1. The reducing power of the snow lotus seed extracts: Vc (*1*), BHT (*2*), SLME (*3*), SLHE (*4*).

The total phenolic contents (TPC) in the SLME and SLHE were determined spectrometrically according to the Folin-Ciocalteu procedure [13] and calculated as GAE equivalent (Absorbance = 0.01564 gallic acid (μg) – 0.0594 (R^2: 0.9976)). The TPC of SLME and SLHE were 9.22 and 4.17 μg/mg, respectively. The TFC of the SLME and SLHE were determined [14] and calculated as rutin equivalent (Absorbance = 9.11332×10^{-4} rutin (μg) + 0.04466 (R^2: 0.99025)).The SLME was found to be richer in flavonoids (31.81 μg/mg) than SLHE (4.78 μg/mg). There is a positive correlation between antioxidant activity potential and the amount of phenolic and flavonoid compounds of extracts.

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