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CHEMICAL COMPOSITION OF THE ESSENTIAL OIL OF *Rhodiola quadrifida* FROM XINJIANG, CHINA

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The chemical composition of a hydrodistilled oil of Rhodiola quadrifida *(Pall.) Fisch. et Mey. growing wild in Xinjiang Uygur Autonomous Region, China was analyzed by GC/MS. Twenty-three constituents were identified. The major components of the oil were hexadecanoic acid (45.39%), 9,12-octadecadienoic acid (33.38%), 9-hexadecenoic acid (3.08%), myristic acid (1.95%), a-terpineol (1.74%), and octadecanoic acid (1.07%).*

Key words: *Rhodiola quadrifida*, essential oil, GC/MS analysis.

The genus *Rhodiola* (fam. Crassulaceae), consisting of about 90 species, is widely distributed in the high cold region of the Northern Hemisphere. In China, there are over 70 species, mainly growing in the Qinghai-Tibet Platean between 1000 and 5600 m in altitudes [1]. A number of *Rhodiola* species have been used as traditional medicines in the treatment of long-term illnesses and weaknesses due to infection for more than 1000 years in China and other countries [2–3]. Recent pharmacological studies found that some *Rhodiola* species such as *R. crenulata* contain many active ingredients, e. g., salidroside, having strong anti-anoxia, anti-fatigue, anti-toxic, anti-radiation, and anti-tumor, anti-aging effects, and are active-oxygen scavengers [4–6].

There are some reports on the phytochemical analysis of *Rhodiola* species, especially on the chemical composition of rhizomes of *Rhodiola* [7–9], but only a very small number of these species, including *R. rosea*, *R. yunnanensis*, *R. crenulata*, and *R. fastigiata*, have been studied for their essential oils [3, 10–13]. Literature survey has shown that *R. quadrifida*, which is one of the major *Rhodiola* resources for medical uses in northwestern China, has not been previously investigated for its essential oil.

We identified a total of 23 compounds in the hydrodistilled oil of *R. quadrifida* from China, with hexadecanoic acid (45.39%), 9,12-octadecadienoic acid (33.38%), myristic acid (1.95%), α-terpineol (1.74%), and octadecanoic acid (1.07%) as the main components (Table 1). Compared with the results obtained from previous studies [3, 10–13], we found that the compounds of essential oils of *Rhodiola* species are significantly different from each other. Further investigation of geographical and seasonal variations of essential oils of some important medical plants in this genus is still needed.

EXPERIMENTAL

Rhodiola quadrifida (Pall.) Fisch. et Mey. was collected from Mt. Tianshan, Xinjiang Uygur Autonomous Region, China in August 2004 at an altitude of 2500 m. A voucher specimen has been deposited in the Ministry of Education, Key Laboratory for Biodiversity Science and Ecological Engineering, Fudan University, Shanghai, China.

The sample was weighed (100 g), then steam distilled with a Clevenger-type apparatus for 3 h; the oil was collected and dried over anhydrous sodium sulfate, then stored at 4°C until analyzed.

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TABLE 1. Composition of the Essential Oil of *Rhodiola quadrifida*

Compound	%	RI*	Compound	%	RI*
Myrcene	0.01	990	*n*-Cetane	0.03	1600
Limonene	0.01	1032	Myristic acid	1.95	1758
Octanol	0.14	1070	Pentadecylic acid	0.83	1859
cis-Linalol oxide	0.05	1095	*n*-Nonadecane	0.28	1900
Benzeneethanol	0.99	1114	9-Hexadecenoic acid	3.08	1943
Octanoic acid	0.60	1168	Hexadecanoic acid	45.39	1965
3-Pinanone	0.18	1186	*n*-Heneicosane	0.79	2100
α-Terpineol	1.74	1199	9,12-Octadecadienoic acid	33.38	2136
Myrtenol	0.08	1206	Octadecanoic acid	1.07	2162
Dihydrocarveol	0.07	1228	5-Eicosene	0.54	2292
Geraniol	0.10	1261	*n*-Tetracosane	0.20	2400
cis-Myrtanol	0.01	1273			

*Retention indices calculated against *n*-alkanes.

The GC/MS analysis was performed on a combined GC/MS instrument (Finnigan Voyager, San Jose, CA, USA) using an HP-5 fused silica capillary column (30 m length, 0.25 mm diameter, 0.25 μm film thickness). A 1 μL aliquot of oil was injected into the column using a 10:1 split injection, which temperature was set at 250°C. The GC program was initiated by a column temperature set at 60°C for 2 min, increased to 250°C at a rate of 10°C/min, and held for 10 min. Helium was used as the carrier gas (1.0 mL/min). The mass spectrometer was operated in the 70 eV EI mode with scanning from 41 to 450 amu at 0.5 s, and the mass source was set at 200°C.

Identification of components was done by comparison of the GC retention indices (RI) relative to C_8 to C_{20} *n*-alkanes and computer matching of their mass spectral fragmentation patterns with those stored in the spectrometer database using the National Institute of Standards and Technology Mass Spectral database (NIST-MS, 1998). The relative percentage amounts of the identified components were calculated from the total ion chromatograms by a computerized integrator.

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