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CHEMICAL VARIATION IN LIPOPHILIC COMPOSITION OF *Lamiophlomis rotata* FROM the QINGHAI-TIBETAN PLATEAU

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Lipophilic extracts from flowers, leaves, and roots of Lamiophlomis rotata *(Benth.) were analyzed using GC-MS. A total of 67 compounds were identified.*

Key words: *Lamiophlomis rotata*, GC-MS analysis, lipophilic composition.

Lamiophlomis (family Lamiaceae) is a monotypic genus with the species *L. rotata* (Benth.) Kudo, which is endemic to the Qinghai-Tibetan Plateau [1]. *L. rotata* is a nonstalk and perennial herb distributed in Bhutan, India (Sikkim), Nepal, and China [2]. In China, it has long been used as a folk medicinal plant to promote blood circulation, remove blood stasis, subdue swelling, and alleviate pain [3]. Current studies have indicated that *L. rotata* can be a remedy for a number of diseases, such as cancer, multidrug resistant tuberculosis (MDR-TB), rheumatic arthritis, and breast swelling [4–9]. More than ten compounds have been isolated from this species, in which four are phenylpropanoid glycosides and seven are iridoids [10, 11]. However, lipophilic extracts in *L. rotata* have not been previously investigated.

We identified a total of 67 compounds in the lipophilic extracts from flowers, leaves, and roots of *L. rotata* from three regions in the Qinghai-Tibetan Plateau, *i.e.*, Tibetan Autonomous Region, Qinghai Province, and Yunnan Province (Table 1). The sixteen major compounds (> 4%) isolated included five common to flowers, leaves, and roots: linolenic acid methyl ester (8.77–11.90% in flowers, 11.19–18.23% in leaves, and 17.31–20.80% in roots), 9,12-octadecadienoic acid (6.90–15.78% in flowers, 2.75–9.36% in leaves, and 8.06–19.11% in roots), hexadecanoic acid (9.97–14.98% in flowers, 7.08–12.42% in leaves, and 9.65–18.54% in roots), β-sitosterol (13.72–16.63% in flowers, 15.04–18.00% in leaves, and 13.05–16.57% in roots), and stearic acid (2.41–4.07% in flowers, 2.02–4.52% in leaves, and tr – 7.83% in roots); one common to flowers and roots, *i.e.*, *n*-cetane (0.12–4.13% in flowers and 0.24–7.17% in roots); one common to flowers and leaves, *i.e.*, *n*-hentriacontane (4.08–7.76% in flowers and 7.18–8.58% in roots); three in flowers only: myristic acid (0.94–4.09%), cyclohexenylacetic acid (2.41–4.07%) and *n*-nonacosane (4.33–4.80%); two in the leaves only: trimethyl-pentadecan-2-ol (5.06–7.50%) and *n*-tritriacontane (0.93–5.08%); and four in roots only: campesterol (3.92–8.83%), *n*-heptadecane (0.26–7.69%), *n*-pentadecane (1.15–5.71%), and *n*-octadecane (tr– 4.93%).

EXPERIMENTAL

Fresh samples of *L. rotata* were collected from eight locations in three regions *i.e.*, Tibet (four locations), Qinghai (two locations), and Yunnan (two locations) in August, 2004. The voucher specimens were deposited at the Ministry of Education Key Laboratory for Biodiversity Science and Ecological Engineering at Fudan University. Plant material was air dried at room temperature for about a month prior to analysis.

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TABLE 1. Lipophilic Composition of *L. rotata* from Qinghai-Tibetan Plateau, %*

Compound	RI	Flower			Leaf			Root		
		Tibet	Yunnan	Qinghai	Tibet	Yunnan	Qinghai	Tibet	Yunnan	Qinghai
n-Octane	818	-	0.13	Tr.	0.47	0.11	0.16	-	0.22	0.12
Dimethylheptane	837	-	Tr.	-	-	Tr.	Tr.	-	0.18	Tr.
Dimethylheptene	857	-	0.12	Tr.	-	0.10	0.13	-	0.37	0.19
α-Pinene	940	0.22	-	-	0.23	-	-	-	-	-
Dimethylnonane	1029	-	Tr.	-	-	Tr.	Tr.	-	0.12	0.12
Methyldecane	1038	-	Tr.	-	-	Tr.	Tr.	-	0.10	Tr.
Dimethyldecane	1062	-	0.34	Tr.	0.12	0.30	0.36	-	0.50	0.44
Butyloctanol	1083	-	0.24	Tr.	Tr.	0.20	0.23	-	0.28	0.26
n-Undecane	1103	-	0.52	Tr.	-	0.25	0.61	-	0.43	0.48
Linalool	1103	-	-	-	0.18	-	-	-	-	-
Dimethyldecene	1105	-	0.23	Tr.	-	0.18	0.23	-	0.39	0.34
Benzeneethanol	1120	-	-	-	0.15	-	-	-	-	-
Tetramethyl-4-piperidone	1124	-	-	-	0.14	-	-	-	-	-
Naphthalene	1195	Tr.	-	-	Tr.	-	-	-	-	-
Dodecane	1202	-	0.10	Tr.	-	Tr.	Tr.	-	0.11	0.12
Dimethylundecane	1231	-	0.24	Tr.	-	0.17	0.24	-	0.30	0.27
Methyldodecane	1283	-	0.36	0.12	-	0.32	0.33	-	0.46	0.42
Dimethyldodecane	1284	0.19	0.78	0.20	0.47	0.85	0.73	-	0.97	0.91
2-Butyl-1-octanol	1325	-	0.30	0.10	-	0.31	0.27	-	0.33	0.36
2-Hexyl-1-octanol	1334	-	0.23	Tr.	-	0.25	0.20	-	0.26	0.28
Trimethyldodecane	1348	-	0.57	0.11	0.34	0.51	0.53	-	0.66	0.20
n-Tetradecane	1401	1.16	0.14	0.15	-	0.41	0.19	2.00	0.80	0.25
Isocaryophyllene	1442	0.20	0.20	Tr.	0.18	Tr.	-	-	-	-
n-Pentadecane	1502	3.48	1.18	0.59	-	2.07	1.06	5.71	2.07	1.15
2,4-Di-*tert*-butylphenol	1539	-	2.09	1.96	1.85	2.86	1.67	2.32	1.48	2.20
2-Hexyl-1-octanol	1544	-	0.18	Tr.	-	0.20	0.17	0.28	0.21	0.21
Trimethyltetradecane	1548	-	0.58	0.27	0.51	0.43	0.55	-	0.81	0.67
1-Tridecanol	1582	-	-	-	0.51	-	-	-	-	-
n-Cetane	1604	4.13	0.17	0.12	2.23	0.79	0.21	7.17	0.77	0.24
7-Methyl-cyclopentapyran-4-carboxylic acid methylester	1611	-	-	-	0.53	-	-	-	-	-
Hexahydrofarnesol	1683	-	-	-	0.41	-	-	-	-	-
Diisobutyl adipate	1690	0.45	-	-	0.66	-	-	-	-	-
n-Heptadecane	1704	3.68	0.37	Tr.	2.73	0.68	0.38	7.69	0.60	0.26
Trimethylpentadecane	1719	-	0.55	0.35	0.61	0.67	0.56	-	0.68	0.63
Tetramethylhexadecane	1758	Tr.	0.62	0.44	0.45	0.41	0.90	-	0.47	0.41
Myristic acid	1765	0.94	2.77	4.09	1.81	2.26	2.80	-	1.40	1.96
n-Octadecane	1804	2.24	-	-	1.57	-	-	4.93	Tr.	Tr.
Trimethylpentadecan-2-ol	1847	1.79	2.85	1.86	7.50	6.35	5.06	-	Tr.	-
Hexahydrofarnesyl acetone	1853	0.49	0.54	0.55	0.91	0.73	0.81	-	-	-
Trimethylpentadecan-1-ol	1890	-	1.32	0.93	3.34	2.89	2.33	3.78	Tr.	-
n-Nonadecane	1900	1.87	0.18	0.13	1.60	0.13	0.10	1.58	-	-
Trimethyloctadecane	1934	0.65	1.15	1.03	0.95	1.41	1.01	0.55	1.28	1.19
Hexadecanoic acid	1967	9.97	11.25	14.98	7.08	12.42	12.22	9.65	16.95	18.54
n-Eicosane	2000	0.75	-	-	0.57	-	-	1.5	-	-
n-Heneicosane		-	-	-	-	-	-	0.74	-	-
Phytol		-	0.64	0.22	2.10	1.56	1.43	-	-	-
9,12-Octadecadienoic acid		6.90	11.38	15.78	2.75	3.54	9.36	8.06	18.63	19.11

TABLE 1. (continued)

Compound	RI	Flower			Leaf			Root		
		Tibet	Yunnan	Qinghai	Tibet	Yunnan	Qinghai	Tibet	Yunnan	Qinghai
Linolenic acid methyl ester		11.90	10.63	8.77	11.19	11.55	18.23	18.38	20.80	17.31
Stearic acid		2.41	4.07	3.81	2.02	4.52	2.92	Tr.	7.83	6.66
Cyclohexenylacetic acid		2.41	4.07	3.36	-	Tr.	Tr.	-	-	-
n-Docosane		0.42	-	-	-	-	-	-	-	-
n-Tricosane		1.03	0.54	-	-	0.45	-	-	0.20	-
9-Octadecenamide		-	1.12	1.14	0.28	0.14	1.67	-	0.39	0.17
n-Tetracosane		0.78	0.44	0.30	0.60	0.37	0.19	-	-	0.11
n-Pentacosane		1.72	1.07	0.76	0.86	0.29	-	-	-	0.13
n-Hexacosane		0.63	0.59	0.50	0.67	0.44	-	-	-	0.16
n-Heptacosane		2.82	2.50	2.00	0.98	0.53	0.49	-	-	Tr.
Glyceryl monostearate		0.33	-	-	-	-	-	-	-	-
n-Octacosane		0.84	0.53	0.50	0.48	0.39	-	-	-	-
Squalene		-	0.77	0.29	0.56	1.16	-	-	-	-
n-Nonacosane		4.33	4.77	4.80	3.29	2.86	2.33	-	-	-
n-Triacontane		0.80	-	-	0.83	-	-	-	-	-
n-Hentriacontane		4.08	6.73	7.76	7.18	8.58	8.45	-	-	0.45
n-Dotriacontane		-	-	-	0.74	-	-	-	-	-
Campesterol		2.82	1.73	1.89	2.69	2.92	1.28	8.83	3.92	4.56
n-Tritriacontane		3.04	1.37	2.18	5.08	0.93	2.34	-	-	1.25
β-Sitosterol		16.63	13.72	16.46	15.04	18.00	15.15	14.84	13.05	16.57
Total		96.10	96.97	98.50	95.44	96.49	97.88	98.01	98.02	98.7

RI: retention indices relative to C8-C20 *n*-alkanes on HP-5 column; Tr.: trace quantities (<0.1% detected); -: not detected.
*Average values over the samples from four locations in Tibet, two locations in Tibet, two locations in Qinghai, and two locations in Yunnan.

The compounds were extracted from dried samples of flowers, leaves, and roots (0.2 g for each sample) with CH_2Cl_2 (1 mL) overnight at room temperature and filtered. The extracts were then stored in a 2 mL glass vial at –20°C until analyzed.

The GC analysis was carried out using a Hewlett-Packard Series 6890 gas chromatograph equipped with FID using a fused silica HP-5 capillary column (30 m long, 0.25 mm in diameter, 0.25 μm film thick). The GC/MS analysis was performed on a combined GC/MS instrument (Finnigan Voyager, San Jose, CA, USA) using the same HP-5 capillary column. A 1 μL aliquot of oil was injected into the column using a 10:1 split injection. The injection port temperature was set at 250°C. The GC program was initiated with the column temperature set at 60°C for 2 min, then increased to 250°C at a rate of 10°C/min, and held isothermal 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 41–450 amu at 0.5 s, and ion source temperature was set at 200°C.

The compositions in the lipophilic extracts were identified by matching 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) and retention indices (RI) relative to C_8–C_{20} alkanes (Sigma Chemical Company, St. Louis, MO, USA). The percentage contents of the composition in each region are average values over the samples from the locations of the region.

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