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Essential oil composition of 'blue flower rosemary' *(Rosmarinus officinalis* L.) from subtropical India

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Abstract

The volatile constituents of aerial parts of the blue flower rosemary (*Rosmarinus officinalis* L.), grown in foot hills of the Himalayas were analyzed by gas chromatography (GC) and gas chromatography-mass spectrometry (GC-MS). Forty compounds, comprising 96.38% of the oil were identified. The major constituents of the oil were camphor (15.64%), α-pinene (11.66%), 1,8-cineole (9.37%), borneol (8.36%), verbenone (8.23%), linalool (5.11%), limonene (4.34%), *exo*-bornyl acetate (4.05%), terpinen-4-ol (3.91%), and camphene (3.87%).

Keywords: rosemary, essential oil, GC-MS, camphor, α-pinene, 1,8-cineole

Introduction

Rosmarinus officinalis L. (Family, Lamiaceae) is an evergreen shrub with a characteristic camphoraceous aroma. It is found throughout the Mediterranean region and is cultivated in several countries such as USA, Spain and Yugoslavia for the production of essential oil (Abdelaziz et al. 2000). Rosemary was introduced in India several decades ago in the Nilgiris since then it is naturalized in different parts of the country (Kalyansundaram and Venkatchalam 1965). The plant is reported to possess carminative, stomachic and spasmodic properties. It is used for the prevention of epilepsy, stimulation of hair growth and dandruff (Lawrence 1986, Soliman et al. 1994). The leaves are reported to be antioxidant due to presence of rosmarinic acid, carnosol, carnosic acid and caffeic acid (Hras et al. 2000, Ramirez et al. 2004). In addition to this, the essential oil of this plant possessed antimicrobial properties against yeast (Domocos et al. 1997), mold (Soliman et al. 1994) and gram-positive bacteria (Farag et al. 1989) and also showed stimulative effect on nervous system (Soliman et al. 1994). The oil contains monoterpenes, oxygenated monoterpenes, aliphatic compounds and benzenoid compounds, which are responsible for the fresh herbaceous top notes and tenacious woody balsamic dry out. A survey of literature reveals that there are mainly three chemotypes: a 1, 8 cineole chemotype

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from France, Greece, Italy and Tunisia, a camphor-borneol chemotype from Spain and a α-pinene and verbenone chemotype from Carsica and Algeria (Boelens 1985, Chalchat et al. 1993, Boutekedjiret et al. 1998). Although the essential oil of white flower rosemary has been subject of several studies from India (Mallavarapu et al. 2000, Rahman et al. 2007, Shawl et al. 2008); but information on the volatile oil of blue flower rosemary from this region are very scanty. This prompted us to carry out detailed GC and GC-MS examination of essential oil of blue flower *R. officinalis* from subtropical region of India.

Materials and Methods

Plant material and isolation of essential oil

Fresh aerial parts of 'blue flower rosemary' (*Rosmarinus officinalis* L.) were obtained from experimental farm of Central Institute of Medicinal and Aromatic Plants, Research Centre Pantnagar, Uttarakhand, India in the month of April. The fresh plant material was immediately subjected to hydro-distillation in Clevenger's apparatus for 3 h to obtained essential oil. The essential oil was dried over anhydrous sodium sulphate and used for analysis.

Gas Chromatography (GC) and Gas Chromatography-Mass Spectrometry (GC-MS)

The GC analysis of the oil sample was carried out on a Perkin-Elmer Auto XL gas chromatograph equipped with FID and PE-5 (50 m x 0.32 mm; 0.25 μm film coating) fused silica capillary column. Hydrogen was the carrier gas at 1.0 ml/min. Temperature programming was done from 100°C - 280°C at 3°C/min. The injector and detector temperatures were 220°C and 300°C. Data was processed on Turbochrome Navigator software. GC-MS recorded on a Perkin Elmer Auto System XL GC and Turbo Mass Spectrometer fitted with fused silica capillary column, PE-5 (50 m x 0.32 mm, film thickness 0.25 μm). The column temperature was programmed 100°C - 280°C at 3°C/min, using helium as carrier gas at constant pressure of 10 psi. MS conditions were: EI mode 70 eV, ion source temperature 250°C. The identification was done on the basis of retention time, Kovats Index, MS Library search (NIST & WILEY), *n*-alkane (C_9-C_{22}) hydrocarbons pattern (Nile, Italy) and by comparing mass spectra with the MS literature data (Adams 1995). The relative amounts of individual components were calculated based on GC peak areas without using correction factors.

Results and Discussion

Hydro-distillation of the fresh aerial parts of rosemary gave an average oil of 0.20% (v/w). GC and GC-MS analysis of the oil resulted in the identification of a total forty components, representing 96.38% of the oil. The oil was mainly composed of oxygenated monoterpenes (61.91%) followed by monoterpene hydrocarbons (27.27%). The identified compounds and their percentage are summarized in Table 1. Camphor (15.64%), α-pinene (11.66%), 1,8-cineole (9.37%), borneol (8.36%), verbenone (8.23%), linalool (5.11%), limonene (4.34%), *exo*-bornyl acetate (4.05%), terpinen-4-ol (3.91%) and camphene (3.87%) were the major constituents of this oil. Other constituents (>1.0%) of the oil were α-terpineol (1.93%), myrtenol (1.92%), linalyl acetate (1.89%), β-pinene (1.48%), *iso*-borneol (1.39%), β-myrcene (1.32%), terpinolene (1.20%), geraniol (1.12%), β-thujone (1.10%), and β-caryophyllene (1.06%). The essential oil composition of white flower rosemary has been investigated from south and north India (Mallavarapu et al. 2000; Rahman et al. 2007). The oil of white flower rosemary was dominated by 1, 8-cineole (26.40% and 23.40%), camphor (26.50% and 26.40%), α-pinene (11.70% and 9.94%) and verbenone (7.0% and 3.32%).

Table 1. Essential oil composition of 'blue flower rosemary' (*Rosmarinus officinalis*) from subtropical India

S. No.	Compound	RT (min)	KI	Peak Area (%)
1.	Tricyclene	3.965	923	0.03
2.	α-Thujene	6.552	927	0.26
3.	α-Pinene	6.770	935	11.66
4.	Camphene	7.202	950	3.87
5.	Sabinene	7.465	975	0.71
6.	1-Octen-3-ol	7.671	977	0.32
7.	β-Pinene	7.841	978	1.32
8.	β-Myrcene	7.891	989	1.48
9.	α-Phellandrene	8.501	1002	0.25
10.	δ-3-Carene	8.712	1008	0.63
11.	α-Terpinene	8.835	1021	0.34
12.	*p*-Cymene	9.057	1025	0.91
13.	Limonene	9.220	1030	4.34
14.	1,8-Cineole	9.405	1035	9.37
15.	γ-Terpinene	10.099	1058	0.66
16.	(*E*)-Sabinene hydrate*	10.464	1068	0.25
17.	Terpinolene	11.164	1085	1.20
18.	Linalool	11.273	1097	5.11
19.	(*Z*)-Sabinene hydrate*	11.576	1099	0.34
20.	α-Thujone	12.598	1105	0.66
21.	β-Thujone	13.398	1116	1.10
22.	Camphor	13.587	1146	15.64
23.	*iso*-Borneol	14.176	1155	1.39
24.	Borneol	14.349	1164	8.36
25.	Terpinen-4-ol	14.689	1175	3.91
26.	α-Terpineol	15.111	1187	1.93
27.	Myrtenol	15.498	1196	1.92
28.	Verbenone	16.102	1204	8.23
29.	Geraniol	17.174	1257	1.12
30.	Linalyl acetate	17.476	1259	1.89
31.	Bornyl acetate	18.549	1284	0.16
32.	*exo*-Bornyl acetate	19.064	1285	4.05
33.	Eugenol	22.387	1360	0.16
34.	Geranyl acetate	22.706	1386	0.39
35.	Methyl eugenol	23.763	1405	0.20
36.	(*E*)-Caryophyllene	25.254	1420	1.06
37.	α-Humulene	26.712	1452	0.20
38.	Caryophyllene oxide	32.296	1583	0.56
39.	α-Muurolol	34.364	1644	0.15
40.	α-Cadinol	35.100	1652	0.25
	Class composition			
	Aliphatic compounds			4.62
	Monoterpene hydrocarbons			27.27
	Oxygenated monoterpenes			61.91
	Sesquiterpene hydrocarbons			1.26
	Oxygenated sesquiterpenes			0.96
	Benzenoids			0.36
	Total identified			96.38

RT: Retention time; KI: Kovat index on PE-5 column (relative to *n*-alkane); *(IPP vs. OH)

Therefore, it is clear that the oil composition of blue flower rosemary is quite different from the oil of white flower rosemary. Further, the essential oil composition of this plant, with unique top note and rich in verbenone and borneol content, shows that it may find application in perfume, medicine and aromatherapy.

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