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SHORT COMMUNICATION

Essential oil composition of *Lavandula angustifolia* Mill. cultivated in the mid hills of Uttarakhand, India

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Abstract: The essential oil content in the inflorescence of lavender (*Lavandula angustifolia* Mill.) cultivated in the mid hills of Uttarakhand was found to be 2.8 % based on the fresh weight. The oil was analysed by capillary GC and GC–MS. Thirty seven constituents, representing 97.81 % of the oil were identified. The major components of the oil were linalyl acetate (47.56 %), linalool (28.06 %), lavanduly l acetate (4.34 %) and *α*-terpineol (3.75 %). The quality of lavender oil produced in India was found to be comparable to that produced in Hungary, France, China, Bulgaria, Russia and the USA.

Keyword: *Lavandula angustifolia*; Lamiaceae; inflorescence; essential oil; GC–MS.

INTRODUCTION

True lavender (*Lavandula angustifolia* Mill. syn. *L. officinalis* Chaix) is a perennial shrub of the family Lamiaceae. It is native to southern Europe and the Mediterranean area and is commerciall y cu ltivated i n France, Spain, Portugal, Hungary, the UK, Bulgaria, Australia, China and t he USA. [1] In India, it was introduced in the Kash mir Valley in 1983, where its commercial cultivation was found to be successful.[2] This plant is c ultivated pri marily for i ts aromatic inflorescence from which the essential oil is isolated, although its fresh and dri ed flowers are also marketed.[3] Lavender oil is known for its excellent aroma and is extensively u sed in the perfumery , flav our and cosmetic industries. The oil is known t o possess sedativ e, car minative, anti-depressive and anti -inflammatory properties.[4] It was also fo und to be active against many species of bacteria, including those resistant to antibiotics, such as methicillin-resistant *Staphylococcus*

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aureus and vancomycin-resistant Enterococcus.[4] Lavender oil was also reported to be an effective antifungal agent against *Aspergillus nidulans* and *Trichophyton mentagrophytes*.[5] The essential oil compositions of lavender grown in different countries were investigated.[6–8]

Oil from lavender cultivated in India may become a significant competitor with historical sources of lavender oil due to the favourable climatic conditions for commercial cultivation in the hilly tracks of northern India.[8] At present, the cultivation of lavender is mainly confined to Jammu and Kashmir. However, the possibilities of commercial cultivation of lavender in other states of North and Northeast India have not yet been explored. Therefore, with the aim of exploring new ecological areas for cultivation of lavender, the crop was introduced in the Kumaon region of the western Himalaya during 2002. The purpose of this study was to investigate the essential oil composition of lavender produced in this region.

EXPERIMENTAL

Plant material

The fresh inflorescence (spikes) of *L. angustifolia* was collected from an experimental field of the Central Institute of Medicinal and Aromatic plants, Resource Centre Bageshwer, Uttarakhand in the month of June when the crop was in full bloom. The experimental site is located in the Kattyur Valley at an altitude of 1250 m, where a sub-temperate mild climate prevails. The voucher specimen of the plant was submitted to the Herbarium division of the Centre.

Essential oil isolation

Freshly harvested plant material (100 g) was immediately subjected to hydrodistillation in a Clevenger's apparatus for 3 h for the extraction of the essential oil. The oil was dried over anhydrous sodium sulphate and stored in a refrigerator at 5 °C prior to analysis.

Gas chromatography (GC)

The GC analyses of the oil sample were realised on a Perkin-Elmer Auto XL GC and a Nucon gas chromatograph model 5765, both equipped with an FID using two different stationary phases, PE-5 (60 m ×0.25 mm; 0.25 μm film coating) and BP-20 (coated with a Carbowax 20M, 30 m×0.32 mm×0.25 μm film thickness), fused silica columns, respectively. Hydrogen was the carrier gas at 1.0 ml/min. The column temperature programming was from 70––250 °C at 3 °C/min (for PE-5) and from 70–230 °C at 4 °C/min (for BP-20). The injector and detector temperatures were 200 and 230 °C on BP-20 and 220 and 300 °C on PE-5 column, respectively. The injection volume was 0.02 μL neat and the split ratio was 1:30.

Gas chromatography–mass spectrometry (GC–MS)

The GC–MS analysis of the oil was performed on a Perkin-Elmer Turbomass Quadrupole mass spectrometer fitted with an Equity-5 (Perkin-Elmer) fused silica capillary column (60 m×0.32 mm; 0.25 μm film coating). The column temperature was programmed 70 °C, initial hold time of 2 min, to 250 °C at 3 °C/min with a final hold time of 3 min, using helium as the carrier gas at a flow rate of 1 ml/min. The injector and source temperatures were 250 °C. The injection volume was 0.06 μL neat with a split ratio 1:30 . The MS were taken at 70 eV with an EI source with mass range of *m*/*z* 40–400. The identification was realised based on the retention indices, an MS Library search (NIST and WILEY), *n*-alkane (C_9–C_{22}) hydrocarbon series (Nile, Italy) and by comparing the mass spectra with MS literature data[8-10]. The relative

amount of the individual components was calculated from the peak area without applying an FID response factor correction.

RESULTS AND DISCUSSION

The essential oil content in the fresh inflorescence of *L. angustifolia* cultivated in the sub-temperate region, the Kumaon region of the western Himalaya was found to be 2.8 %. However, the essential oil content in the inflorescence of different accessions of lavender grown in temperate parts of Kashmir was only 0.80 to 1.3 %.[11] These variations could either be due to difference of the plant genotype[3] or to the altitude and microclimate of the cultivation area.

The results of GC and GC–MS analyses of the essential oil together with the European Pharmacopoeia 5.0 standards (EP 5) are given in Table I. The major constituents (> 1.0 %) of the oil were linalyl acetate (47.56 %), linalool (28.06 %), lavandulyl acetate (4.34 %), α-terpineol (3.75 %), geranyl acetate (1.94 %), caryophyllene oxide (1.38 %) and 1,8-cineole (1.14 %). Other minor components (< 1.0 and > 0.10 %) identified in the oil were β-caryophyllene (0.93 %), borneol (0.85 %), *epi*-α-cadinol (0.70 %), nerol (0.59 %), terpinen-4-ol (0.56 %), β-myrcene (0.55 %), limonene (0.55 %) and 1-octen-3-ol (0.53 %). However, the major components reported in the lavender oil from different countries were linalool (27.3–42.2 %), linalyl acetate (27.2–46.6 %), (*Z*)-β-ocimene (0.2–11.6 %), terpinen-4-ol (0.70–4.6 %), lavandulyl acetate (0.50–4.8 %), β-caryophyllene (1.8––5.1 %), (*E*)-β-ocimene (0.30–3.8 %), α-terpineol (0.30–2.0 %) and 1,8-cineole (0.10–1.2 %).[8]

TABLE I. GC–MS analysis of the essential oil of *Lavandula angustifolia* from Uttarakhand, India

Compound	*KI*[a]	*KI*[b]	Area, %	EP 5[c], %
Tricyclene 924		921	0.03	–
α-Pinene 935		932	0.09	–
Camphene	951	946	0.23	–
Sabinene 974		969	0.04	–
1-Octen-3-ol 995		974	0.53	–
β-Myrcene 998		988	0.55	–
1-Hexyl acetate	1015	1007	0.11	–
p-Cymene 1025		1020	0.09	–
Limonene	1030	1024	0.55	< 1.0
1,8-Cineole 1035		1026	1.14	< 2.5
(*E*)-β-Ocimene 1047		1044	0.08	–
(*Z*)-Linalool oxide (furanoid)	1072	1067	0.22	–
(*E*)-Linalool oxide (furanoid)	1090	1084	0.24	–
Linalool	1098	1095	28.06	20–45
1-Octen-3-yl acetate	1106	1110	0.35	–
Camphor 1146		1141	0.11	< 1.2
Lavandulol	1162	1165	0.25	> 0.1

TABLE I. Continued

Compound	*KI*[a]	*KI*[b]	Area, %	EP 5[c], %
Borneol	1165	1165	0.85	–
Terpinen-4-ol 1177		1174	0.56	0.1–6
p-Cymen-8-ol 1183		1179	0.06	–
α-Terpineol 1189		1186	3.75	< 2.0
Myrtenol 1195		1194	0.13	–
Nerol	1225	–	0.59	–
Geraniol 1237		1254	0.21	–
Linalyl acetate	1257	1257	47.56	25–46
Lavandulyl acetate	1285	1288	4.34	> 0.2
p-Menthyl-8-acetate 1346		–	0.42	–
Thymol acetate	1355	–	0.13	–
Neryl acetate	1356	1359	1.07	–
Geranyl acetate	1373	1379	1.94	–
β-Cadinene 1416		–	0.11	–
β-Caryophyllene 1419		1417	0.93	–
(*E*)-Isoeugenol	1449	–	0.17	–
γ-Cadinene 1511		1513	0.12	–
Elemol	1552	–	0.12	–
Caryophyllene oxide	1584	1582	1.38	–
epi-*α*-Cadinol 1639		1638	0.70	–
Total identified, %			97.81	

[a]Kovats index experimental (PE-5 column; relative to *n*-alkane); [b]Kovats index, literature[8,10]; [c]European Pharmacopoeia 5.0

On comparison of the present results with those reported from other parts of India, it is quite evident that the concentrations of 1,8 cineole, camphor, *β*-caryophyllene and caryophyllene oxide were slightly higher, whereas the concentrations of *α*-terpineol, linalyl acetate, geranyl acetate, neryl acetate and lavandulyl acetate were relatively lower in the Kashmir oil than in the present oil.[12] However, the lavender oil reported from the Kashmir valley contained large amounts of limonene (11.0 %), citronellol (10.0 %) and *α*-terpineol (7.6 %) and low contents of linalool (10.0 %).[2] Furthermore, the concentrations of (*E*)-*β*-ocimene, 1-octen-3-yl acetate, *α*-terpineol and *β*-caryophyllene were slightly higher in the oil produced in Kodaikanal when compared to the present oil.[13] These variations could be due to differences in location, elevation, genetic makeup of the plant or due to an adaptive process to particular ecological conditions. Lawrence also observed a wide variation in the quantitative composition of lavender oil depending on plant genotype and cultivation area, and the composition of the oil from lavenders were recognized to vary significantly according to altitude, microclimate and region.[14–16]

CONCLUSIONS

In the oil from *L. angustifolia* growing in Uttarakhand, the components linalool, limonene, 1,8-cineole, camphor, lavandulol, lavandulyl acetate and terpinen-4-ol were found to be well within the desired limit mentioned in EP 5, while the concentration of linalyl acetate and α-terpineol slightly exceeded the EP 5 specifications. However, 3-octanone was not detected in the present oil (0.10–2.5 % in EP 5). Thus, the composition of the lavender oil produced in Uttarakhand was comparable to the oils produced in Hungary, France, China, Bulgaria, Russia and the USA.[8] Finally, this study suggested that the agro-climatic conditions of Uttarakhand are ideal for growing lavender of international standards, and can be exploited by giving proper opportunities to the farmers.

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И З В О Д

САСТАВ ЕТАРСКОГ УЉА БИЉКЕ *Lavandula angustifolia* Mill. ГАЈЕНЕ У ПЛАНИНСКОМ ПОДРУЧЈУ УТАРАКАНДА, ИНДИЈА

RAM S. VERMA[1], LAIQ U. RAHMAN[2], CHANDAN S. CHANOTIYA[2], RAJESH K. VERMA[1], AMIT CHAUHAN[1], ANJU YADAV[2], ANAND SINGH[1] и AJAI K. YADAV[1]

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Етарско уље лаванде (*Lavandula angustifolia* Mill.), гајене у планинском подручју Утараканда, чини 2,8 % свеже масе биљке. Уље је анализирано методама капиларне GC и GC–MS. Идентификовано је тридесет седам састојака, који су чинили 97,81 % уља. Главни састојци уља су линалил-ацетат (47,56 %), линалол (28,06 %), лавандул-ацетат (4,34 %) и α-терпинеол (3,75 %). Квалитет овог лавандиног уља је сличан квалитету уља произведеног у Мађарској, Француској, Кини, Бугарској, Русији и САД.

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