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DOI: 10.37722/AAHAE.2021603

Research Article | Advances in Agriculture, Horticulture and Entomology | AAHE-161
ISSN 2690-1900

Comparison Composition of Lavender and Lavandin Volatiles Cultivated In Kashmir Himalayas Which Have Potential to Be Versatile Industrial Crops of the Region

S. A. Gangoo*, A. R. Malik, Peerzada, Ishtiak, Amarjeet, Singh

Faculty of Forestry, S. K. University of Agricultural Scelences and Technology of KashmirBenhama, Ganderbal-J&K, India

Received Date: November 16, 2021; **Accepted Date:** November 26, 2021; **Published Date:** December 02, 2021;

***Corresponding author:** S. A. Gangoo, Faculty of Forestry, S. K. University of Agricultural Scelences and Technology of Kashmir Benhama, Ganderbal-J&K, India. Email: gangoo_sajad@yahoo.com

Abstract

Species of Lavender have a commanding position in essential oil and pharmaceutical industry among the aroma bearing plants. Lavender oil has been the subject of numerous studies over the years and detailed chemical analysis from various parts of the world has been carried out. True lavender (*Lavendula angustifolia*) and lavandin (*Lavendula X intermedia*) have been cultivated for essential oil in Kashmir Himalayas. The main constituents of oil identified by GC and MS analysis are 25 compounds in Lavandin and 50 compounds in Lavender. The main constituents in lavandin are: Linalool (32.18%), Camphor(16.33), Linalyl acetate (8.29), 1,8- Cineole (2.79) and α-pinene (1.67), while the main constituents in true lavender are 25.75% of linalool, 44.98% linalyal acetate, 1.49% of terpineol, 2.7% of borneol, 1.07% of camphor, 3,44% of lavandulyl acetate, 1.85% of caryophyllene, 2.08% of caryophyllene oxide etc. Linalool, the important pharmaceutical compound, is present more in Lavandin than in Lavender, but camphor content in lavandin is high. The constituents found in the Lavandula spp. of Kashmir Himalayas are of international standards when compared with those cultivated elsewhere in the world. The constituents are as per the range given by European Pharmacopoeia. Preferably linalool should be 20-45 %, linalylacetate 25 - 46 % and camphor to be less than 1.2 % of in lavender oil.

Keywords: Lavandin, *Lavender, Lavendula angustifolia, Lavendula X intermedia,* Linalool*,* Linalyal acetate**.**

Introduction

Species of Lavender have a commanding position in essential oil and pharmaceutical industry among the aroma bearing plants. Genus *Lavandula* (lamiaceae) is represented by 39 species and 17 hybrids (Upson & Andrews, 2004). *Lavendula angustifolia* Chaix. Syn. *L. officinalis* which is known as true lavender, is the most valued of all lavender species both for its high quality oil and as garden plant. It is a perennial bushy shrub 50-80 cm tall with attractive flowers borne in short compact to long interrupted spikes on a distinct and unbranched peduncle. It has attractive violent - blue to purple shaded flowers. Lavenders are extensively cultivated in France, U.K., Bulgaria, New Zealand, Hungary, Australia, China, Russia, Moldova, Ukraine, Morocco, India and to a limited extent in USA for industrial oil and agro-tourism as lavender tours and festivals conducted in lavender parks are becoming more popular. *Lavendula X intermedia*, known as Lavandin is naturally occurring hybrid between *L. angustifolia* and *L. latifolia*. Lavandin is extensively cultivated and commonly grown lavender, dominating the world's production of Lavender oil. The total production of *lavandula* oil in the world is 2000 tons of which 70% is lavandin oil. Lavandin plant is typically much larger and robust 1-1.5m in height. The flower spikes are 20 cm long and number of flower per cyme reach 9 to 15. Leaves are broader compared to narrow to narrow linear of *Lavendula angustifolia*.

Lavender oil has been the subject of numerous studies over the years and detailed chemical analysis from various parts of the world have been carried out (Naef & Morris, 1992; Boelens 1995; Oszagyan*et al*. 1996; Cavanagh & Wilkinson, 2002; Barocelli et al 2004; Moon et al. 2006 etc.). However limited detailed GC and GC-MS analysis of Lavender cultivated in Kashmir-Himalayas is reported (Shawl et al 2005).

The aim of this study is to cultivate Lavender and lavandin in Kashmir valley, analyze its constituents and compare them with the crop cultivated elsewhere in the world so that they become versatile industrial crops of the region.

Materials and Methods

Flower spikes of true lavender (*Lavandula angustifolia*) and hybrid lavender, lavandin (*Lavendula X intermedia*) were harvested from plants cultivated at Faculty of Forestry, Benhama, Ganderbal, Kashmir on the southern slopes (1660m) of Lar mountains a part of Himalayas. These flower spikes were steam distilled for 2 hours. The oil obtained was dried over anhydrous Na_2SO_4 and stored at low temperature prior to analysis.

Gas chromatography Mass spectrometry (GC/ MS) analysis

Chemical constituents of essential oils extracted from flower spikes were analysed using Gas chromatography-Mass spectrometry (GC/MS) on a Thermo Fisher TRACE GC ULTRA coupled with DSQ II Mass spectrometer instrument using a TR 50MS column (30 m x 0.25 mm ID x 0.25 µm, film thickness). Constant flow at 1 mL/min of carrier gas (Helium) was used for whole analysis. The injector temperature of the instrument was 220°C; oven temperature was programmable starting from 50°C, with hold time 5.0 min to 250°C with ramp of 4°C/min, with hold time of 5 minutes. The ion source temperature was set at 220°C; transfer line temperature was 300°C. The ionization of the sample components was performed in EI mode at an ionization voltage of 70 eV. Mass range was used from m/z 50 to 650 amu. Essential oil was diluted with hexane and injected in split mode (1:50) with injection volume 1 µL. The relative proportion of the sample constituents were obtained (% area) by FID peak-area normalization. Retention indices (RI) of the sample components were determined on the basis of homologous n-alkane hydrocarbons. The retention indices were obtained by co-injecting the oil components with C8-C20 linear hydrocarbon mixtures. The volatile components were analyzed by GC/MS and identification was done by comparing retention indices and mass spectra with those in the literature and MS Library search (NIST and WILEY)/ comparison with authentic compounds. Standards and samples were injected in GC/ MS on the same programming method. The relative amount of components calculation is based on peak area obtained by response factor of detector.

Results and discussion

The volatile oil was obtained by steam distillation of flowering spikes of *Lavendula X intermedia* (lavandin) in 2% yield on fresh weight basis while as it was 1.02% in *Lavandula angustifolia* (true lavender). The oils showed following physical properties, Lavandin oil: colour- light yellow, specific gravity- 0.8905, refractive index -1.4671, optical rotation -10.0º at 20ºc, acid value 1.460 having hay like woody, camphoraceous, floral fresh note; True lavender: has a typical herbal floral note, the top note having green, hay-like, fruity aspects and on drying out being sweet and woody having specific gravity same as of lavindin (0.8905). GC-MS analysis resulted in the identification of 50 constituents in lavender oil while only 25 constituents were identified in Lavandin. The relative concentrations of volatile constituents are presented in **Table-1**. The major constituents in the Lavandin oil from Kashmir Himalayas are Linalool (32.18%), Camphor(16.33%), Linalyl acetate (8.29%), 1,8- Cineole (2.79%) and α- pinene (1.67%). The volatile compounds of lavender oil from Kashmir Himalayas identified are: linalool (25.57%), linalyal acetate (44.98%), terpineol (1.49%), borneol (2.7%), camphor (1.07%) lavandulyl acetate (3.44%), caryophyllene (1.85%) and caryophyllene oxide (2.08%). Fatma (2019) has reviewed the principal constituents of *lavandula* essential oil reported from different places of the world. Linalool, linalyl acetate and camphor contents were found in different studies cultivated in different countries. These three components were selected for the purpose of her study because linalool and linalyl acetate contents are two major constituents, and low content of camphor is very important because it gives lavender oil the undesirable odor (Adams and Yanke 2007). In all the studies linalyl acetate is high in the lavender oil while linalool is higher in the lavandin oil and same has been confirmed in our study. Lavender oil is mostly used for perfume, cosmetics and pharmaceutical industries. According to the European Pharmacopoeia reference values, lavender oil must contain linalool between 20-45 %, linalyl acetate between 25 - 46 % and less than 1.2 % of camphor (Adams and Yanke 2007). According to these standards the lavender oil cultivated in Kashmir meets these international standards. Lawrence, 1993 has reported the constituents in lavender oil as: linalool (29-46%), linalyal acetate (36-7.6%), 1,8-cineole (0.1-2.2%), caryophyllene (2.5-7.6%), terpineol (2.7-6.9%), ocimene (2.5-7.6%) and lavandulyl acetate (3.4 – 6.2%). Tomi *et a*l. (2018) have reported that Lavender oils contain more than 100 compounds, with the two major constituents being linalool and linalyl acetate. Other constituents include α-thujene, α-pinene, camphene, sabinene, β-pinene, myrcene, pcymene, limonene, 1, 8-cineole, (Z)- and (E)-β-ocimene, 7-terpinene, camphor, terpinen-4-ol, lavandulol, lavandulyl acetate, β-caryophyllene etc. and all these constituents were found in our study too. According to another study conducted by Baydar and Kineci (2009), lavender oil contains linalool between 30 - 45 % and linalyl acetate between 20 - 30 %. Alatrache et al. (2007) reported that linalool (47.8 %), camphor (11.8 %) and linalyl acetate (10.7 %) were the principal constituents of the flowers oils of *L. angustifolia* Mill. in Italy ; linalool (32.8 %), linalyl acetate (17.6 %), lavandulyl acetate (15.9 %), α-terpineol (6.7 %) and geranyl acetate (5.0%) were found to be the major constituents in Iran (Fakhari et al. 2005); major components were camphor and 1,8-cineole, up to 80.9 and 76.7 % in leaves; 87.8 and 85.2 % in flowers in Spain (Sanz et al. 2004) . Various sampling techniques used for the study of many Lavandula species showed that linalyl acetate (35.44 %) and linalool (18.70%) as predominant components in South Korea (Nam and Dong2002); and a study of essential oil of *L. angustifolia* from Australia showed that linalool (41.2 %), linalyl acetate (16.1 %) and terpinen-4-ol (12.1%) were the principal compounds (An *et al.* 2001) . Alatrache*et al.* (2007) identified forty components in their own study and found that the main constituents of the oil were linalool (32.3 %), 1,8-cineole (11.7 %), camphor (12.4 %), lavandulol (8.7 %), terpinen-4-ol (7.7%) and bornyl acetate (4.2 %), methyl carvacrol (1.9 %), linalyl acetate (1.8 %), β-pinene (1.6 %), α-terpineol (1.5 %) and p-cymene (1.5 %) were other notable constituents of the oil in Tunisia while Archana and Negi (2012) reported that *L. angustifolia*'s essential oil has major aroma constituents linalool and linalyl acetate up to 60 % from India, whereas oil of *L. stoechas* is rich in camphor and fenchone and as a good source of pharmaceutical products. The variation of constituents at various places is due to the fact that this variation exists due to environment, location, elevation and due to adaptive process to a particular ecological condition.

S.No.	Compound	%Composition	
		Lavender	Lavandin
1	Methyl-n-hexyl ether	0.02	0.64
2	Ethyl 2-methyl butyrate	0.02	-
3	Cis 3-hexenol	0.06	0.28
4	Hexenolformate	0.04	0.58
5	Tricyclene	0.02	-
6	α- pinene	0.22	1.67
7	Camphene	0.34	0.69
8	Sabinene	0.07	-
9	1-Octen-3-ol	0.18	0.18
10	Octanone-3	0.9	-
11	Myrcene	0.22	0.46
12	Isobutyl butyrate	0.05	-
13	Octanol-3	0.11	-
14	Hexyl acetate	0.28	0.22
15	Para-cymene	0.24	-
16	Limonene	0.33	1.48
17	1,8- Cineole	2.1	2.79
18	E-β- Ocimene	0.03	-
19	Z-β- Ocimene	0.06	-
20	Thujanol	0.02	0.19
21	Cis-Linalool oxide	0.49	-
22	Trans-Linalool oxide (furan)	0.48	-
23	Linalool	25.27	32.18
24	Octen-3-yl acetate	0.66	-
25	Bicyclo-heptan-3-ol	0.1	2.02
26	Camphor	1.07	16.33
27	Octadiene-diol	0.05	0.37
28	Borneol	2.7	1.75
29	Lavandulol	0.4	-
30	Terpinen-4-ol	0.72	-
31	Hexyle butyrate	0.29	0.58
32	α-Terpineol	1.49	1.77
33	Verbenone	0.07	-
34	Isobornylformate	0.1	-
35	Geranoil	0.16	-
36	Cumin aldehyde	0.14	-
37	Carvone	0.06	-
38	Linalyl acetate	44.98	8.29
39	Geranial	0.06	-
40	Bornyl acetate	0.51	-
41	Lavandulyl acetate	3.44	-
42	Neryl acetate	0.44	-
43	Geranial acetate	0.81	-
44	E-β-Caryophyllene	1.85	0.2
45	α-Bergamotene	0.12	-
46	α-Humulene	0.05	-
47	Z-β-Farnesene	0.67	0.3
48	Dimethyl-octatriene	0.51	-
49	γ- Cadinene	0.14	0.25
50	Caryophyllene	2.08	0.92

Table 1: Comparison of chemical constituents in the essential oils of true lavender and Lavandin

Linalool and linalyl acetate contents of *Lavendula* oil are used as the criterion of quality (Shellie *et al*.2002). From **Table 1** it is quite evident that Kashmir lavender oil is (linalool ≥ 25% and linalyal acetate ≥ 44%) of the international standards. The lavandin cultivated in Kashmir has more linalool (32. 18%), 1,8- Cineole(2.79%) but the content of camphor is more (16.33%) which makes this oil less superior than lavender oil. The maximum content of linalool (47.8%) has been reported in lavandin of Italy (Chemat, *et al*. 2006) and minimum of (23.6%) in lavender cultivated in Himachal Pradesh, India (Archana & Negi, 2012). Maximum content (46.6%) of linalyal acetate has been reported in commercial brands of India (Adams &Yanke 2007) while as minimum content (1.8%) has been reported in *L. latifolia* of Tunisia (Altrache*et a*l. 2007). Maximum camphor content (≥ 80%) has been reported in *L. luisieri* L. cultivated in Spain (Sanz*et a*l. 2004) while minimum content of camphor (0.3%) has been reported commercial brands of India, France, China and Bulgaria (Adams &Yanke 2007).

There are huge differences between lavandin oil and lavender oil prices. Demand for lavender oil, as the main driver for price determination, does not vary a lot from one year to another (Fatima *et al.*2019). Kashmir Himalayas has conducive atmosphere for cultivation of *Lavandula* spp. of international standard but should not be considered as a product with easy farming and modest requirements but for its value adding in order to be competitive in the world market. Further development will require a more in-depth understanding of the economics of the lavender value chain and the essential oil business for being competitive in the world market.

Conclusions

This study has revealed that lavender and lavandin cultivated in Kashmir has the same ingredients as is cultivated and marketed in European countries. It is now evident that Kashmir lavender oil is (linalool ≥ 25% and linalyal acetate ≥ 44%) of the international standards. The lavandin cultivated in Kashmir has more linalool (32. 18%).

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Citation: *Gangoo S A, Malik A R, Peerzada, Ishtiak, Amarjeet et al. (2021) Comparison composition of lavender and lavandin volatiles cultivated in kashmir himalayas which have potential to be versatile industrial crops of the region. Adv Agri Horti and Ento: AAHE-161.*