

Research Article



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## Sesquiterpene rich essential oil from *Teucrium quadrifarium* Buch Ham ex D. Don. from Uttarakhand Himalaya of India

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### Abstract

*Teucrium quadrifarium* Buch. Ham. Ex D. Don was collected from Nainital (2100 m), Uttarakhand India. The fresh flowering aerial parts were subjected to steam distillation, which afforded pale yellow coloured oil (0.5 %, v/w). The essential oil composition was determined with the help of GC and GC-MS, identifying 37 compounds, the volatile constituent showed the dominance of sesquiterpenoid hydrocarbons viz. (*E*)-caryophyllene (40.3%), germacrane D (15.5%) and valencene (11.4%). Monoterpene hydrocarbons, oxygenated hydrocarbons and oxygenated sesquiterpenoids were noticed in very less amount.

**Keywords:** *Teucrium*, Lamiaceae, (*E*)-caryophyllene, germacrane D

### 1. Introduction

Genus *Teucrium* (Family: Lamiaceae) includes 300 species widespread globally. It shows difference from other related genera in its corolla. The genus *Teucrium* has been used medicinally as anti-asthmatic, anti-pyretic, anti-helmenthic, anti-rhumatic [22].

*Teucrium quadrifarium* Buch. Ham. ex. D. Don is an erect herb with pink flowers concealed by a bract in racemes i.e four sided in bud conditions, leaves shortly stalked, cordate, oblong-ovate and toothed. It is found in temperate region ascending to 2500 m in Nainital [14].

The genus *Teucrium* is rich in diterpenes containing neoclerodane skeleton. Many of these diterpenes are ecologically important as antifedants against different insect species and their role in the medicinal properties of plants. Several *Teucrium* species were analysed for their essential oil composition having

different yield in various species, ranging between 0.5% to 1.5% and the percentage contents of the major chemical constituents differ significantly from one species to another [22]. In earlier reports about the volatile constituents of genus *Teucrium*, *T. melissoides* revealed -pinene, -pinene, limonene and germacrene D as the major constituents [3]. -Cadenine, (*E*)-caryophyllene was found as major components in the volatile constituent of *T. montanum* [25]. The leaf essential oil of *T. marum* showed isocaryophyllene and -bisabolene as major compounds [24].

Many species of this genus show hypoglycemic, hypolipidemic, anti-inflammatory, anti-ulcer, anti-oxidant and antimicrobial properties. Some of the species of *Teucrium* are used in flavoured wines, herbal teas and liquors [1, 8]. The *Teucrium* genus is known for the antibacterial, antifungal, and antioxidant activity of essential oils. Extract in methanol of

*Teucrium royleanum* have antibacterial and antifungal potential [19], the essential oil of *T. ramosissimum* showed weak to moderate activity for its antifungal and antibacterial assays [16], crude ethanolic extract of *T. polium* showed good cytotoxic activity [21] and the essential oil of *T. stocksianum* subspecies *Stocksianum* collected from Oman showed good antimicrobial activity at flowering stage [26].

## 2. Materials and Methods

### 2.1 Plant material

The fresh aerial parts of *T. quadrifarium* Buch. Ham. ex. D. Don were collected from Pangoot, Nainital district of Uttarakhand (1500 m). Plant herbarium was identified from the Botanical Survey of India, Dehradun (**Acc. No. 114152**) and voucher number and specimen has been deposited in the Phytochemistry research laboratory, Chemistry Department of DSB campus, Kumaun University, Nainital.

### 2.2 Extraction of essential oil

The fresh aerial part of plant was subjected to steam distillation. The distillates were saturated with sodium chloride and extracted with *n*-hexane and DCM. The organic phase was dried over anhydrous Na<sub>2</sub>SO<sub>4</sub> and the solvent was distilled off in a rotary vacuum evaporator at 28°C.

### 2.3 GC and GC-MS analysis

The volatile oil was analyzed by using Nucon 5765 GC equipped with Rtx-5 non-polar fused silica capillary column (30 m × 0.32 mm, 0.25 μm film coating). The oven temperature (60-200°C) was programmed at 3°C min<sup>-1</sup> using N<sub>2</sub> as carrier gas at 4 Kg cm<sup>-2</sup>. The injector temperature was 200°C, detector temperature 200°C and the injection volume 0.5 mL, using a 10% solution of the oil in *n*-hexane. GC-MS was conducted on a ThermoQuest Trace GC 2000 interfaced with a Finnigan MAT PolarisQ ion trap mass spectrometer equipped with Rtx-5 non-polar fused silica capillary column (30 m × 0.25 mm, 0.25 μm film coating). The oven temperature (60-200°C) was programmed at 3°C min<sup>-1</sup> using helium as carrier gas at 1.0 min<sup>-1</sup>. The injection, ion source and MS transfer line temperatures were 210°C, 220°C and 275°C, respectively, the injection volume was 0.1 mL, and the split ratio was 1:40. Mass spectra were taken at 70 eV with mass range of 40-450 amu.

### 2.4 Isolation and identification of the constituents

The volatile oil was fractionated by column chromatography on silica gel CC packed with *n*-hexane, and eluted with hexane followed by elution with Et<sub>2</sub>O/hexane (5 to 18%). Characterization of

constituents was done on the basis of Linear Retention Index under identical experimental condition, co-injection with available compounds, MS Library search (NIST and WILLEY) and by comparing with the known MS literature data [2]. The relative contents of individual components were calculated GC response.

## 3. Results and Discussion

The oils of *Teucrium melissoides*, *Teucrium polium* subspecies *capitatum*, *Teucrium lusitanicum*, *Teucrium algarbiensis* and *Teucrium polium* subspecies *aurasiacum* were rich in -pinene and -pinene [4, 6, 12, 17]. -Pinene was found as a main constituent in the oil of *Teucrium libanitis* [11].

The volatile constituents of *Teucrium melissoides*, *Teucrium flavum*, *Teucrium chamaedrys* collected from Iran [4, 7, 23] *Teucrium orientale* L. var. *orientale*, *Teucrium pestalozzae*, *Teucrium antitauricum*, *Teucrium orientale* var. *puberulens*, and *Teucrium chamaedrys* subspecies *lydium* collected from Turkey [9, 10, 20, 27] contained germacrene-D among the main constituents while in *Teucrium atratum* from Algeria [18] and *Teucrium capitatum* from Portugal [9] contains -cadinol as a main constituents. -cadinol was also identified in *T. stocksianum* collected from Iran [17], *T. polium*, *T. ramosissimum* from Tunisia, *T. stocksianum* from UAE *T. leucocladum* and *T. capitatum* from Portugal [5, 13, 15, 18].

The reported results on essential oil of *Teucrium* species vary in terpenoid constituents. The constituents of the essential oil in the present investigation are given in **Table 1**. Steam distillation of the leaves of *T. quadrifarium* gave yellow oil with pleasant smell. The yield of the oil was 0.5% (v/w). The essential oil showed a total of 48 constituents of which 37 were identified. Sesquiterpene hydrocarbons 89.2% dominated by (*E*)-caryophyllene (40.3%), germacrene-D (15.5%), valencene (11.4%), (*E*)-farnesene (7.8%) and -humulene(6.4%) while monoterpene accounted for 3.4% of the identified compounds.

Table 1. Essential oil composition of *T. quadrifarium* Buch Ham

S. NO.	COMPOUNDS	LRI	% FID	MODE OF IDENTIFICATION
1.	-pinene	939	1.2	a,b
2.	sabinene	978	t	a,b
3.	-pinene	981	0.7	a,b
4.	myrcene	1005	t	a,b
5.	<i>p</i> -cymene	1029	t	a,b
6.	limonene	1033	0.4	a,b
7.	( <i>E</i> )- $\alpha$ -ocimene	1054	t	a,b
8.	linalool	1100	t	a,b
9.	<i>cis</i> -pinocarveol	1143	t	a,b
10.	borneol	1167	t	a,b
11.	terpineol-4	1170	t	a,b
12.	-terpineol	1197	0.1	a,b
13.	<i>cis</i> -carveol	1250	t	a,b
14.	thymol	1288	t	a,b
15.	carvacrol	1296	t	a,b
16.	<i>p</i> -methoxyacetophenone	1315	t	a,b
17.	-elemene	1340	0.8	a,b
18.	-cubebene	1351	0.2	a,b
19.	-copaene	1378	t	a,b
20.	-bourbonene	1391	2.0	a,b
21.	( <i>E</i> )-caryophyllene	1418	40.3	a,b,c
22.	-gurjunene	1432	1.2	a,b
23.	-cedrene	1410	0.1	a,b
24.	-elemene	1425	0.1	a,b
25.	aromadendrane	1440	0.9	a,b
26.	-humulene	1454	6.4	a,b
27.	( <i>E</i> )- $\beta$ -farnesene	1458	7.8	a,b
28.	germacrene D	1480	15.5	a,b,c
29.	valencene	1510	11.4	a,b
30.	bicyclogermacrene	1522	0.1	a,b
31.	-bisabolene	1535	1.5	a,b
32.	-cadinene	1546	t	a,b
33.	-calacorene	1550	t	a,b
34.	germacrene B	1558	1.8	a,b
35.	-muurolol	1580	0.1	a,b
36.	-eudesmol	1651	t	a,b
37.	-cadinol	1675	t	a,b
	Total identified		92.6%	
	Monoterpene hydrocarbons		3.4%	
	Sesquiterpene hydrocarbons		89.2%	

\*a= Linear Retention Index (LRI), b=MS (GC-MS), c=NMR ( $^1\text{H}$  &  $^{13}\text{C}$ ), t = trace, less than 0.1%

#### 4. Conclusion

It is interesting that very low amount of oxygen containing monoterpenes and oxygenated sesquiterpenes were identified in the oil, but the oil was found rich in sesquiterpene hydrocarbons (89.2%). On the other side, our result shows somewhat different result from the previously reported data on the volatile constituents of some other *Teucrium* species. *Teucrium quadrifarium* Buch. Ham. Ex D. Don contained  $\alpha$ -pinene and limonene in minor amounts and it was found to contain traces of thymol, linalool, carvacrol,  $\beta$ -cadinol and  $\gamma$ -cadinol which primarily found in the oils obtained from other *Teucrium* species.

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#### 6. References

1. Abdollahi M., Karimpour H., Monsef-Esfehani H.R., 2003. "Antinociceptive effects of *Teucrium polium* L. total extract and essential oil in mouse writhing test", *Pharmacological Res.* 48: 31-35.
2. Adams R.P., 2001. "Identification of Essential Oil Components by Gas Chromatography-Mass Spectrometry", Allured Publishing Corp., Carol Stream, Illinois, USA.
3. Ahmadi L, Shahmir F., 2002. "Essential oil of *T. melissoides*", *J. Essent. Oil Res.* 14: 355.
4. Ahmadi L, Mirza M, Shahmir F., 2002. "Essential oil of *Teucrium melissoides* Boiss. et Hausskn.ex Boiss", *J. Essent. Oil Res.* 14: 355.
5. Al-Yousuf M.H., Bashir A.K., Dobos A., Veres K., Nagy G., Mathe I., Blunden G., 2002 "The composition of the essential oil of *Teucrium stocksianum* from the United Arab Emirates", *J. Essent. Oil Res.* 14: 47-48.
6. Antunes T., Sevinate-pinto I., Barroso J.G., Cavaleiro C., Salgueiro L.R., 2004. "Micromorphology of trichomes and composition of essential oil *Teucrium capitatum*", *Flav. Fragr. J.* 19: 336-340.
7. Baher Z.F., Mirza M., 2003. "Volatile constituents of *Teucrium flavum* L. from Iran", *J. Essent. Oil Res.* 15: 106-107.
8. Barrachina M.D., Bello R., Martinez-Cuesta M.A., Esplugeus J., Primo-Yufera E., 1995. "Anti-inflammatory activity and effects on isolated smooth muscle of extracts from different *Teucrium* species", *Phytotherapy Res.* 9: 368-371.
9. Baser K.H.C., Demircakmak B., Duman H., 1997. "Composition of the Essential oil of three *Teucrium* species from Turkey", *J. Essent. Oil Res.* 9: 545-549.
10. Baser K. H. C., Demirci B., Duman H., Aytac Z., 1999. "Composition of the Essential Oil of *Teucrium antitauricum* T.Ekim", *J. Essent. Oil Res.* 11: 61-62.
11. Blazquez M.A., Perez I., Boira H., 2003. "Essential oil analysis of *Teucrium libanitis* and *T. turredanum* by GC and GC-MS", *Flav. Fragr. J.* 18: 497-501.
12. Cozzani S., Muselli A., Desjobert J.M., Bernardini A.F., Tomi F., Casanova J., 2005. "Chemical composition of essential oil of *Teucrium polium* subsp. *capitatum* (L.) from Corsica", *Flav. Fragr. J.* 20: 436.
13. El-Shazly A.M., Hussein K.T., 2004. "Chemical analysis and biological activities of the essential oil of *Teucrium leucocladum* Boiss. (Lamiaceae)", *Biochem. System. Ecol.* 32: 665-674.
14. Gupta R.K., 1968. "Flora Nainitalensis, A Hand Book of the Flowering Plants of Nainital, Navayug Traders, New Delhi. India. 282.
15. Hachicha S.F., Skanji T., Barrek S., Ghrabi Z.G., Zarrouk H., 2007. "Composition of the essential oil of *Teucrium ramosissimum* Desf. (Lamiaceae) from Tunisia", *Flav. Fragr. J.* 22: 101-104.
16. Helander I.M., Alkomi H. L., Latva-Kala K., Mattila-Sandholm T., Pol I., Smid E.J., Gorris L.G.M., Von Wright A., 1998. "Characterization of the Action of Selected Essential Oil Components on Gram-Negative Bacteria", *J. Agric. Food Chem.* 46: 3590-3595.
17. Jaimand K., Rezae M.B., Soltanipoor M.A., Mozaffarian V., 2006. "Volatile Constituents of *Teucrium stocksianum* Boiss. ssp. *stocksianum* from Iran", *J. Essent. Oil Res.* 18: 476-477.
18. Kabouche A., Touafek O., Nacer A., Kabouche Z., Bruneau C., 2006. "Volatile oil constituents of *Teucrium atratum*. Pomel from Algeria", *J. Essent. Oil Res.* 18: 175-177.
19. Knoblock K., Pauli A., Iberl B., Weis N., Weigand H., 1988. "Antimicrobial and antifungal properties of essential components", *J. Essent. Oil Res.* 1: 119-128.
20. Kucuk M., Gulec C., Yasar A., Ucuncu O., Yayli N., Coskunçelebi K., Terzioglu S., Yayl N., 2006. "Chemical Composition and Antimicrobial Activities of the Essential Oils of *Teucrium chamaedrys* subsp. *chamaedrys*, *T. orientale* var. *puberulens*, and *T. chamaedrys* subsp. *lydium*", *Pharm. Biol.* 44: 592-599.
21. Magwa M.L., Gundidza M., Gweru N., Humphrey G., 2006. "Chemical composition and biological activities of essential oil from the leaves of *Sesuvium portulacastrum*", *J. Ethnopharmacol.* 103: 85.

22. Menichini F., Conforti F., Rigano D., Formisano C., Poizzi F., Senatore F., 2009. "Phytochemical composition, anti-inflammatory and antitumor activities of four *Teucrium* essential oils from Greece", Food Chem. 115: 679-686.
23. Morteza-Semnani K., Akbarzadeh M., Rostami B., 2005. "The essential oil composition of *Teucrium chamaedrys* L. from Iran", Flav. Fragr. J. 20: 544-546.
24. Ricci D., Fraternali D., Giamperi L., Bucchini A., Epipfano F., Burini G., Curini M., 2005, "Chemical composition, antimicrobial and antioxidant activity of the essential oil of *Teucrium marum*", J. Ethnopharmacol. 98: 195-200.
25. Vukovic N., Milosevic T., Sukdolak S., Solujic S., 2007. "Antimicrobial activities of essential oil and methanol extract of *T. montanum*", Evid-Based-complement-Med. 4:17-20.
26. Watabe T., Hiratsuka A., Isobe M., Ozawa N., 1980. "Metabolism of *d*-limonene by hepatic microsomes to non-mutagenic epoxides toward *Salmonella typhimurium*", Biochem. Pharmacol. 29: 1068-1071.
27. Yildirim A., Cakir A., Mavi A., Yalcin M., Fauler G., Taskesenligil Y., 2004. "The variation of antioxidant activities and chemical composition of essential oils of *Teucrium orientale* L. var. *orientale* during harvesting stages", Flav. Fragr. J. 19: 367-372.

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