Constituents of *Artemisia gmelinii* Weber ex Stechm. from Uttarakhand Himalaya: A Source of Artemisia Ketone

S. Z. HAIDER, H. C. ANDOLA* AND M. MOHAN[1]
Centre for Aromatic Plants (CAP), Industrial Estate, Selaqui-248 197, [1]Department of Chemistry, D. A. V. (P.G) College, Dehradun-248 001, India

The essential oils isolated from the aerial parts of two different populations of *Artemisia gmelinii* growing in Uttarakhand Himalaya region were analysed by gas chromatography and gas chromatography/mass spectrometry (GC-MS) in order to determine the variation of concentration in their constituents. Artemisia ketone was detected as a major constituent in both the populations i.e., Niti valley and Jhelum samples. Niti oil was found to have considerably greater amounts of artemesia ketone (53.34%) followed by α-thujone (9.91%) and 1,8-cineole (6.57%), Similarly, the first major compound in Jhelum oil was artemesia ketone (40.87%), whereas ar-curcumene (8.54%) was identified as a second major compound followed by α-thujone (4.04%). Artemisia ketone can be useful for perfumery and fragrance to introduce new and interesting herbaceous notes.

Key words: Artemesia ketone, *Artemisia gmelinii*, Asteraceae, essential oil composition

***Address for correspondence**
E-mail: andolah@rediffmail.com

Artemisia gmelinii Weber ex Stechm. (Asteraceae), a bushy aromatic shrub, is found in the alpine regions of Kashmir, Kinnaur and Kumaon on the interior ranges bordering Tibet between altitudes of 2700-5100 m[1,2]. In Uttarakhand Himalaya, the herb of *A. gmelinii* is used as incense by the local inhabitants due to its aromatic odour. The essential oil of *Artemisia* species is also finding its place in the indigenous perfumery industries. The essential oil composition of different *Artemisia* species viz. *A. capillaris*, *A. edgeworthii, A. gmelinii*, *A. maritima*, *A. myriantha*, *A. nilagirica*, *A. parviflora, A. roxburghiana*, *A. verlotiorum* and *A. wallichiana,* has been a matter of investigation for several investigators in India, especially from Uttarakhand region. Major compounds are thujone, β-caryophyllene, β-eusesmol, γ-terpinene, 1,8-cineole, ar-curcumene, artemisia ketone, borneol, camphor, capillene, caryophyllene oxide, chrysanthenone, germacerene D, terpinen-4-ol and vulgarone B have been reported[3-13].

In spite of many essential oil related studies on the genus *Artemisia,* there are still many problems in systematic interpretations. The quality and quantity of the essential oil varies a lot with the genetic makeup of the taxa and the prevalent environmental factors. In the present study, both the oils were dominated by artemisia ketone which has green herbaceous odour and has been suggested for use in perfumery to introduce new and interesting herbaceous notes, particularly for men's fragrances[14]. In view of the above, the present study is designed so as to study the quantitative and qualitative variation in the constituents of *A. gmelinii*.

The aerial parts of *A. gmelinii* were collected from Niti valley (3620 m) and Jhelum (3000 m) regions of Uttarakhand Himalaya in the month of September, 2007. Voucher specimen has been duly identified and deposited in the herbarium of Botanical Survey of India (BIS), northern circle, Dehradun (BSD 112167).

Air dried aerial parts (300 g) of the plants were hydro-distilled for 3 h using a Clevenger-type apparatus. The oils were greenish in colour and had characteristic odour. The distillated oils were dried over anhydrous sodium sulphate, and stored in tightly closed vials at 4° for analysis. The essential oil content was determined as percentage on fresh weight basis as an average of three independent extractions of each site to minimise error. The combined oil was used for further analysis.

About 0.1 µl of each pure oil sample was subjected to gas chromatography (GC) and gas chromatography/ mass spectrometry (GC/MS) analyses. The GC was composed of an Agilent Technology 6890 N gas chromatograph data handling system equipped with a split-splitless injector and fitted with a flame ionization detector (FID) using N_2 as the carrier gas. The column was HP-5 capillary column (30 m×0.32 mm, 0.25 µm film thickness) and temperature program was used as follows: Initial temperature of 60° (hold: 2 min) programmed at a rate of 3°/min to a final temperature of 220° (hold: 5 min). Temperatures of the injector and FID were maintained at 210° and 250°, respectively.

The GC/MS analyses were carried out on a Perkin Elmer Clarus 500 gas chromatograph equipped with a split-splitless injector (split ratio 50:1) data handling system. The column was an Rtx®-5 capillary columns (60 m×0.32 mm, 0.25 µm film thickness). Helium (He) was the carrier gas at a flow rate 1.0 ml/min. The GC was interfaced with (Perkin Elmer Clarus 500) mass detector operating in the EI^+ mode. The mass spectra was generally recorded over 40-500 amu which revealed the total ion current (TIC) chromatograms. Temperature program used was the same as described above for GC analyses. The temperatures of the injector, transfer line and ion source were maintained at 210°, 210° and 200°, respectively.

Identification of the individual components was made by matching their recorded mass spectra with the library (NIST/Pfleger/Wiley) provided by the instrument software, and by comparing their calculated retention indices with literature value[15,16]. Relative area percentages of the individual components were obtained from GC-FID analyses.

The composition of the essential oils obtained from *A. gmelinii* is presented in Table 1. Altogether, 39 essential compounds were identified by GC and GC/MS representing 90.54% (Niti oil) and 89.60% (Jhelum oil). Both oils were dominated by oxygenated monoterpenes, representing 79.65% and 58.18% in Niti and Jhelum oils, respectively. The Niti oil revealed the presence of artemesia ketone (53.24%), α-thujone (9.91%) and 1,8-cineole (6.57%). Similarly, the major compound in Jhelum oil was artemesia ketone (40.87%), followed by ar-curcumene (8.54%)

TABLE 1: COMPOSITION OF THE ESSENTIAL OIL OF *ARTEMISIA GMELINII* COLLECTED FROM TWO LOCATIONS OF UTTARAKHAND HIMALAYA

Compounds	RI_{lit}	RI_{exp}	Composition (%)	
			Niti oil	Jhelum oil
Artemisia triene	923	929	3.21	3.93
α-thujene	924	930	0.09	-
α-pinene	932	939	0.11	0.81
Camphene	946	953	-	0.53
Sabinene	969	975	0.45	0.71
1-octen-3-ol	972	982	0.31	0.71
β-pinene	974	979	0.19	0.49
Myrcene	988	991	-	0.68
α-phellandrene	1002	1003	0.17	0.37
p-cymene	1020	1025	0.31	0.30
1,8-cineole	1026	1033	6.57	3.69
Artemisia ketone	1056	1062	53.34	40.87
Trans-sabinene hydrate	1098	1098	-	1.18
Nonanal	1100	1098	0.98	0.79
α-thujone	1102	1101	9.91	4.04
β-fenchyl alcohol	1112	1113	-	0.12
β-thujone	1114	1114	1.08	0.39
Camphor	1141	1142	0.98	0.89
Sabina ketone	1154	1156	0.13	0.26
Pinocarvone	1160	1161	0.52	0.23
Terpinen-4-ol	1174	1177	1.56	1.16
α-thujenal	1181	1180	-	0.27
cuminic aldehyde	1238	1239	0.99	0.55
trans-geraniol	1249	1247	3.13	2.82
decanoic acid	1364	1364	0.15	0.21
Trans-caryophyllene	1417	1419	0.17	2.36
α-guaiene	1437	1439	-	2.72
α-humulene	1452	1455	-	0.57
β-farnesene	1454	1457	0.22	0.69
ar-curcumene	1479	1474	2.31	8.54
germacrene D	1484	1485	0.31	2.06
α-zingiberene	1493	1489	0.32	1.89
β-bisabolene	1505	1509	0.24	0.55
Caryophyllene oxide	1582	1583	0.30	0.82
Vulgarone B	1649	1651	1.58	1.76
2-pentadecanone	1697	1699	0.20	0.40
Farnesol	1722	1722	0.16	0.51
Hexadecanol	1874	1870	0.25	0.32
Eicosane	2000	2000	0.30	0.41
Monoterpene hydrocarbons			4.53	7.82
Oxygenated monoterpenes			79.65	58.18
Sesquiterpene hydrocarbons			3.57	19.38
Oxygenated sesquiterpenes			2.79	4.22
Total identified			90.54	89.60

and α-thujone (4.04%). Although, artemesia ketone was detected as the major compound in both the sites, it decreased with the increasing altitudes. In an earlier study on *A. gmelini* from Uttarakhand Himalaya[13], the major constituent of the oil showed similarity with the present investigation, but the variations occurred in the quantitative composition of both the studies, whereas a report from Central Asia differed with our study with respect to their major constituents. They reported 1,8-cineole (21-40%), camphor (10-31%) and borneol (4-17%) as the major constituents in *A. gmelini* oil[17]. The present study concluded that in both the sites the oil components quantitatively varied from each other, but qualitatively both oils were similar except for some minor components.

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