Constituents of *Artemisia indica* Willd. from Uttarakhand Himalaya: A source of davanone

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ABSTRACT

Background: The genus *Artemisia* is important due to its medicinal properties as well as vital aroma compounds of commercial value. **Objective:** The aim of the study was to explore the potential of the essential oil of *Artemisia indica* wildly growing in Uttarakhand. **Materials and Methods:** The aerial parts of *Artemisia indica* Willd. (Asteraceae), collected from wild growing habitat of Garhwal Himalaya, Uttarakhand (north of India) at full flowering stage were hydro-distilled and gave pale yellow oil with the yield of 0.8% (v/w). The obtained essential oil was analyzed by GC and GC-MS and identified 32 components, amounting 95.42% of the oil. **Results:** Among detected compounds, the principal component was found to be davanone (30.80%), followed by β-pinene (15.30%) and germacrene-D (5.82%). **Conclusion:** To the best of our knowledge, this is the first report on *A. indica* from Himalayan region of India, which detected davanone as major component. The species, collected from a specific location, can be explored for isolation of davanone for its industrial utilization and as alternate source of *Artemisia pallens,* which have already established commercial value.

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INTRODUCTION

Genus *Artemisia* L. (Family Asteraceae) is widely distributed throughout the world, especially in north temperature region of South Africa, most common on arid soil of United States and Russian Steppes with approximately 400 species and 32 in India.[1] The large genus *Artemisia* from the tribe Anthemideae comprises important medicinal plants, which are currently the subject of phytochemical attention because of their biological and chemical diversity and essential oil production. This genus is industrially important due to its anti-microbial, insecticidal, antioxidant, and anti-malarial properties as well as perfumery compounds.[2-7] *Artemisia* is one the most widely studied genus for its morphological and chemical diversity.[8] *Artemisia* species from different origin showed a dominant presences of α-thujone, β-thujone, 1,8-cineole, germacrene-D, vulgarone-B, borneol, β-caryophyllene, caryophyllene oxide, davanone, artemisiaketone, and chrysanthenone.[9-16] Previous study on *Artemisia indica* from Kumaun Himalaya (India) reported β-caryophyllene, germacrene-D, caryophyllene oxide, and cis-β-elemenone as the major components.[14,15] Davana (*Artemisia pallens* Wall. ex. DC.) is a major source of davana oil and commercially cultivated in South India.[17] There is a greater demand in the world market for davana oil; hence, it is obvious to make attempts for exploration of new alternate aroma source of the davana oil from the Himalayan wild growing *Artemisia* species. We, therefore, decided to explore the potential of the essential oil of *Artemisia indica*.

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MATERIALS AND METHODS

Plant material

Artemisia indica was collected during the full bloom stage from plants growing wild in Chakrata region (altitude 1914 m; 30°31'08.68" N latitude, 77°50'39.07" E longitude) of Uttarakhand (India). The plant specimen was identified in Botanical Survey of India (BSI), Northern Circle, Dehradun (Uttarakhand). A voucher specimen (Acc. no. 114559) was deposited at the herbarium of BSI.

Isolation of essential oil

The air-dried aerial parts (150 g) were chopped and subjected to hydro-distillation for 4 hours using a Clevenger apparatus. The oil obtained, was dried over anhydrous sodium sulfate, yielding 0.8% (v/w) on the dry weight basis, and stored in dark vial at low temperature before analysis.

Gas chromatography

The gas chromatography (GC) analyses of the oil samples was carried out using Agilent (HP7890 GC) gas chromatograph equipped with a Flame Ionization Detector (FID) and a HP-5 fused silica column (30 m × 0.32 mm, 0.25 μm film thickness). The sample was injected directly into the column. Nitrogen was used as a carrier gas during analysis. The injector and detector temperature were maintained at 210°C and 230°C, respectively. The column oven temperature was programmed from 60° to 220° with an increase in rate of 3°/min. The injection volume was 0.2 μL.

Gas chromatography-mass spectrometry

Analysis of the oil was performed out on Agilent mass spectrometer (Model 5975C) coupled to an Agilent gas chromatograph with a 60 m × 0.32 mm, 0.25 μm film thickness column (DB5). The sample was injected directly in split less mode. Helium was used as the carrier gas (flow rate 1 mL/min). The oven temperature was programmed from 60° to 220° at 3°C/min. Other conditions were the same as described under GC. The mass spectrum was taken with a mass range of 40-600 Daltons.

Identification of components

The identification of constituents was performed on the basis of retention index (RI), determined with reference to the homologous series of n-alkanes, C_8-C_{24} with co-injection of standards (Sigma Aldrich USA) under same analytical conditions and by matching their recorded mass spectra with the MS library (NIST/Pfleger/Wiley) and available literature.[18]

RESULTS AND DISCUSSION

The composition of the essential oils of *A. indica* is presented in Table 1. Altogether, 32 compounds were identified by GC and GC/MS, representing 95.42%. Results showed that oxygenated sesquiterpenes (33.83%) were the major portion with davanone (30.80%) as the main compound, followed by monoterpene hydrocarbons (25.90%), sesquiterpene hydrocarbons (20.54%), and oxygenated monoterpenes (15.15%). The other major components in the oil were found to be β-pinene (15.30%), germacrene-D (5.82%), β-elemene (4.93%), cymene (4.30%), trans-caryophyllene (3.81%), and linalool (3.60%) including other notable minor components; 1,8-cineole (2.28%), τ-muurolol (2.01%), β-myrcene (1.72%), limonene (1.63%), sabinene (1.31%), ar-curcumene (1.30%), and δ-cadinene (1.30%) etc. Previously, two studies were carried out on the essential oil composition of *A. indica* from Uttarakhand Himalaya and reported β-caryophyllene, germacrene-D, and cis-β-elemenone as major components while davanone was completely absent, even not in trace.[14,15] Though, till date, *A. pallens* is a source of famous davana oil, which contains davanone, and India is earning Rs. 70.49 lakh per annum from the export of davana oil.[17] It is recognized as one of the most useful oil for formulating natural flavors that are used in cakes, pastries, beverages, and tobacco in United States of America, Europe, and Japan.[19] However, in context of another earlier report from Himalaya, davanone (5.5%) was found in appreciable amount in *A. elegantissima* var. *Kumaunensis* collected from district Chamoli of Uttarakhand.[16]

Table 1: Chemical composition of *Artemisia indica* essential oil from Uttarakhand Himalaya (India)

Components	RI	Percentage composition
α-pinene	939	0.90
sabinene	975	1.31
β-pinene	979	15.30
β-myrcene	991	1.72
cymene	1025	4.30
limonene	1029	1.63
1,8-cineole	1031	2.28
cis-ocimene	1037	0.48
γ-terpinene	1060	0.26
linalool	1097	3.60
chrysanthenone	1128	0.36
trans-pinocarveol	1139	1.51
pinocarveol	1165	0.65
borneol	1169	0.39
terpinen-4-ol	1177	0.54
p-menth-1-en-8-ol	1180	0.57
myrtenal	1196	3.39
iso-pulegol	1215	0.26
piperitone	1253	1.60
β-elemene	1391	4.93
trans-caryophyllene	1419	3.81
β-fernesene	1457	0.33
α-humulene	1455	0.85
ar-curcumene	1481	1.30
γ-himanchalene	1483	0.95
germacrene-D	1485	5.82
β-selinene	1490	0.48
γ-cadinene	1514	0.77
δ-cadinene	1523	1.30
davanone	1588	30.80
τ-muurolol	1646	2.01
α-cadinol	1665	1.02
Monoterpene hydrocarbons		25.90
Oxygenated monoterpenes		15.15
Sesquiterpene hydrocarbons		20.54
Oxygenated sesquiterpenes		33.83
Total identified (%)		95.42

RI: Retention index relative to n-alkanes (C_8-C_{24}) calculated on a HP-5 capillary column

A recent report on essential oil of the *A. indica* collected from Kashmir Himalaya reported artemisia ketone (42.1%), germacrene-B (8.6%), borneol (6.1%), and cis-chrysanthenyl acetate (4.8%),[20] whereas *A. indica* originated from Nepal dominated by ascaridole (15.4%), isoascaridole (9.9%), trans-p-mentha-2,8-dien-1-ol (9.7%), and trans-verbenol (8.4%) as major components.[21] These reports have disagreement with the present investigation due to diversity in their compositions. It is well established that lot of qualitative and quantitative variation in essential oil composition depends on harvesting times and habitat features.[22] This difference may be occurred due to environmental and geographical influences, but the existence of chemo variation under the same conditions determined by genetic factors.[23,24]

CONCLUSION

Present study concluded that *A. indica*, collected from a specific location, can be explored for isolation of davanone for its industrial utilization and various industrial applications as well as alternate source of *Artemisia pallens,* which have already established commercial value. Due to the potential applications of davanone, there is a need to develop agro-technology for commercial scale mass multiplication of the species.

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