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*Review article*

# Diversity of *Artemisia* in the Himalayan States in response to ethnopharmacology, phytochemistry and biological activities: A review

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**ABSTRACT**
The Indian Himalayan region has been recognized as one of the best habitats for medicinal plants. Around 400 species of medicinal plant *Artemisia* are distributed throughout temperate regions of the world. These species are used as traditional medicines by indigenous cultures and many show biological activities including antimalarial, cytotoxic, antihepatotoxic, antibacterial, antifungal and antioxidant activities. The present study highlights the ethnopharmacology, phytochemistry and biological activities of different eleven species of *Artemisia* along various Himalayan States. This study recommends that it is an urgent need to implement appropriate strategies for the conservation and management of different valuable species of *Artemisia* in these Himalayan states for the purpose of enhancement of livelihood security, alternative employment opportunities and sustainable development.



## INTRODUCTION

In India, of the 960 traded medicinal plant species, 178 species are consumed in volumes exceeding 100 metric tons per year, with their consolidated consumption accounting for about 80% of the total industrial demand of all botanicals in the country. Analysis of these 178 species by their major sources of supply reveals that 21 species (12%) are obtained from temperate forests, 70 species (40%) from tropical forests, 36 species (20%) largely or wholly from cultivations or plantations, 46 species (25%) largely from roadsides and other degraded land use elements and the remaining 5 species (3%) are imported from other countries (Ved and Goraya, 2007).

The Indian Himalayan region is the home of 1748 medicinal plants, of which 25.8% species are native to the Himalayan region, 5.66% species native to the Himalayan region and neighbouring biogeographic domains, together: 3.55% species endemic and 11.9% species are near-endemic to the IHR. Medicinal plants form an integral part of the daily activity of most of the hill communities and inhabitants are known to collect these plants from natural habitats mainly for their own use or for trade (Samant et al., 1998; 2007).

The plant diversity of the Himalayan region is defined by the monsoonal rains, up to 10,000mm rainfall, concentrated in the summer, altitudinal zonation, consisting of tropical lowland rainforests, 100–1200 m asl, up to alpine meadows, 4800–5500 m asl. Hara and co-workers have estimated there to be around 6000 species of higher plants in Nepal, including 303 species endemic to Nepal and 1957 species restricted to the Himalayan range (Hara et al., 1978; 1979; 1982). The Indian Himalaya is home to more than 8000 species of vascular plants (Singh and Hajra, 1996) of which 1748 are known for their medicinal properties (Samant et al., 1998).

Higher plants have played key roles in the lives of tribal peoples living in the Himalayas by providing forest products for both food and medicine. Numerous wild and cultivated plants have been utilized as curative agents since ancient times, and medicinal plants have gained importance recently, not only as herbal medicines but also as natural ingredients for the cosmetic industry. In the present review, the species diversity of *Artemisia*, a highly valuable medicinal plant has been summarized in view of ethnopharmacology, phytochemistry and biological activities from Bhutan, Nepal, and the Indian Himalaya of Uttarakhand, Himachal Pradesh, and Jammu and Kashmir.

### The Genus *Artemisia*

There are approximately 400 species of *Artemisia* distributed throughout temperate regions of the world, and the genus is typically characterized by aromatic shrubs and herbs (Mabberley, 2008). Numerous members of the genus are used as traditional medicines by indigenous cultures, and many show biological activities including antimalarial, cytotoxic, antihepatotoxic, antibacterial, antifungal and antioxidant activities (Bora and Sharma, 2011). Some particularly notable members of the genus include *A. absinthium* L., the major component of the notorious spirit drink absinthe (Lachenmeier et al., 2006); *A. annua* L., the efficacious antimalarial drug qinghaosu (Klayman, 1985); *A. dracunculus* L., the flavouring herb tarragon (Obolskiy et al, 2011); and *A. tridentata* Nutt., the "big sagebrush" of western North America (Winward, 1980).

In the Himalayas, 19 species of *Artemisia* are recognized to be medicinal herbs (*A. absinthium, A. biennis, A. brevifolia, A. desertorum, A. dracunculus, A. dubia, A. gmelinii, A. indica, A. japonica, A. lacinata, A. macrocephala, A. maratima, A. moorcroftiana, A. nilagarica, A. parviflora, A. roxburghiana, A. scoparia, A. sieversiana,* and *A. vulgaris*) (Sah et al., 2010; Semwal et al., 2015), and some of these have been investigated for volatile compositions and bioactivity as given below.

***Artemisia dracunculus***

*A. dracunculus* (tarragon) is used worldwide, including in the Himalayan region, as a flavouring agent for food. The plant is also used ethnobotanically. Native peoples in the Nubra Valley (Kashmir) (Kumar et al., 2009), Kibber Wildlife Sanctuary (Himachal Pradesh) (Devi et al., 2013), and the Lahaul Valley (Himachal Pradesh) (Singh and Chauhan, 2005) use a paste from the leaves to treat wounds on the legs of donkeys and yaks; an extract of the whole plant is used to relieve toothache, reduce fever, and as a treatment for dysentery, intestinal worms, and stomachache. *A. dracunculus* from the Himalayas is a rich source of the diacetylene capillene and monoterpene (Z)-ocimene (Chauhan et al., 2010; Mir et al., 2012; Verma et al., 2010) and is markedly different from French tarragon, which is dominated by estragole (up to 74%), or Russian tarragon, which is dominated by elemicin (up to 57%), or other cultivars of *A. dracunculus* (Obolskiy et al., 2011).

***Artemisia dubia***

The leaf juice of *A. dubia* is used by villagers in the Dolpa district of Nepal (Kunwar and Adhikari, 2005) and the Newar community of Kathmandu, Nepal (Balami, 2004), as an antiseptic to cure cuts and wounds and the leaf extracts are used as pesticides. The essential oil of *A. dubia* was shown to be rich in chrysanthenone (29.0%), coumarins (18.3%), and camphor (16.4%). Although the leaf oil showed in vitro cytotoxic activity against MCF-7 human breast tumour cells and antifungal activity against *Aspergillus niger,* it was inactive against the bacteria *Bacillus cereus, Staphylococcus aureus, Escherichia coli,* and *Pseudomonas aeruginosa* (Satyal et al., 2012). Thus, the antiseptic qualities of *A. dubia* must be due to non-volatile components in the plant.

***Artemisia gmelinii***

In the Humla district of northwestern Nepal, the whole fresh plant of *A. gmelinii* is ground into a paste and applied externally to cure headache, boils, and pimples (Rokaya et al., 2010). The essential oils from the aerial parts of *A. gmelinii* from Himalayan India are dominated by artemisia ketone and 1,8-cineole (Mathela et al., 1994; Haider et al., 2012). Neither of these compounds, however, is notably antibacterial (*B. cereus, S. aureus, E. coli, P. aeruginosa*) or antifungal (*Candida albicans*, *A. niger*) (Setzer et al., 2004).

***Artemisia indica***

The essential oil composition of *A. indica* has shown wide variation. The leaf essential oil from Nepal was dominated by ascaridole (15.4%), isoascaridole (9.9%), trans-p-mentha-2, 8-dien-1-ol (9.7%), and trans-verbenol (8.4%) (Satyal et al., 2012). Conversely, the essential oil from the aerial parts of a sample from Uttarakhand, India was rich in davanone (30.8%), pinene (15.3%), and germacrene D (5.8%) (Haider et al., 2014), while the aerial parts essential oil from a sample collected from Kashmir was dominated by artemisia ketone (42.1%), germacrene B (8.6%), and borneol (6.1%) (Rashid et al., 2013). The oil from Kashmir was screened for antimicrobial activity and showed extraordinary activity against *S. aureus* and *Penicillium chrysogenum* (MIC = 16 g/mL). The Kashmir oil also showed remarkable cytotoxic activity against THP-1 (leukaemia), A-549 (lung), HEP-2 (liver) and Caco-2 (colon) human tumour cells. The Nepali A. indica oil showed neither antibacterial (*B. cereus, S. aureus, E. coli, P. aeruginosa*), antifungal (A. niger), nor cytotoxic (MCF-7 breast tumour) activities (Satyal et al., 2012). In Nepal, the leaves are used to make a paste that is applied to cuts and wounds (Uprety et al., 2010; 2011), while the juice of the plant is used to treat indigestion (Balami, 2004).

***Artemisia japonica***

In the Garhwal Himalaya, Uttarakhand, the leaves of *Artemisia japonica* are used as an incense and insecticide (Bhat et al., 2013) and in ethnoveterinary medicine, the plant is used as a treatment for internal parasites (e.g., roundworm) (Pande et al., 2007). In northern Pakistan, the leaf extract is used to treat malaria while a paste of the leaves is applied externally to treat skin diseases (Ashraf et al., 2010). The essential oil from the aerial parts of *A. japonica* collected from Milam glacier (Uttarakhand), India, was dominated by the monoterpenoids linalool (27.5%), (E)-_-ocimene (6.5%), 1,8-cineole (5.5%), and (Z) ocimene (5.5%), along with germacrene D (11.2%) (Joshi, 2015). In contrast, a sample of *A. japonica* from southern India (Munmar, Kerala) was rich in sesquiterpene hydrocarbons: Spathulenol (12%), germacrene D (7.5%), elemene (2.8%), caryophyllene (2.4%) (Rashmi et al., 2014).

***Artemisia maritima***

*Artemisia maritima* is used by several Himalayan peoples to treat stomach problems and for expelling intestinal worms (Ashraf et al., 2010; Kumar et al., 2009; Srivastava et al., 1986). Mathela and co-workers (Mathela et al., 1994) found *A. maritima* essential oil from Malari (Garhwal region, India) to be rich in thujone (63.3%), sabinene (7.8%), and 1,8-cineole (6.5%), while 1,8-cineole and chrystanthenone dominated the essential oils from Himachal Pradesh (Ashraf et al., 2010) and Chamoli (Garhwal region, India) (Joshi, 2015). Camphor was the dominant monoterpenoid (44.4%) in an essential oil sample from Lahaul-Spiti (Himachal Pradesh, India) (Singh et al., 2012), which was screened for antimicrobial activity (*S. aureus, E. coli, S. abony, P. aeruginosa, C. albicans*), but was found to be inactive. Commercial *A. maritima* oil from Pakistan was also rich in 1,8 cineole

(41.1%) and camphor (20.3%) (Shah et al., 2011). Thujone has shown anthelmintic activity (Albert-Puleo, 1978), and high concentrations of thujone in some *A. maritima* essential oils likely account for the ethnopharmacological use of this plant to expel intestinal parasites. The compound is a potent neurotoxin and modulator of the GABA-gated chloride channel, however (Höld et al., 2000). Conversely, camphor has been shown not to have anthelmintic activity (Caius and Mhaskar, 1923), but the compound is toxic to humans and ingestion may cause seizures (Köppel et al., 1982; Patra et al., 2015). 1,8-Cineole has been shown to inhibit castor oil-induced diarrhoea in rats (Patra et al., 2015), prevents ethanol-induced gastric injury in rats (Santos and Rao, 2001), and attenuates trinitrobenzene sulfonic acid-induced colitis in rats (Santos and Silva, 2004), and so this compound may be an important component in the traditional use of 1,8-cineole-containing herbal medicines for stomach related problems.

***Artemisia nilagirica***

*Artemisia nilagirica* is widely found in the hilly areas of northern India, where it is used as an insecticide (Abad et al., 2012). *A. nilagirica* essential oil compositions have shown altitudinal variation. Badoni and co-workers (Badoni et al., 2009; 2010) found that *A. nilagririca* from lower altitudes in Uttarakhand (500 m asl) contained thujone (36.9%) as the major component, the oil from intermediate elevation (1200 m asl) had mequinyl p-nitrobenzoate (22.1%), cadina-1,4-diene (17.7%), and eudesmol (12.4%) as the major components, and the sample from higher elevation (2000 m asl) had linalool (32.5%) and isopulegyl acetate (20.7%) as the major components. Haider and co-workers (Sharma et al., 2004), working in Himachal Pradesh, observed a similar effect, albeit with a very different composition. *A. nilagririca* from lower altitudes (Mandi, 1044 m asl) contained caryophyllene oxide (28.6%) as the major component, the oil from intermediate elevation (Manali, 2050 m asl) had borneol (35.8%) as the major component, and the sample from higher elevation (Shimla, 2210 m asl) was dominated by camphor (46.9%).

The *A. nilagirica* essential oil from Himachal Pradesh [major components: camphor (12.6%), artemisia ketone (10.2%), caryophyllene oxide (7.4%), borneol (5.3%)] showed antifungal activity against the plant pathogenic fungi *Colletotrichum acutatum, Colletotrichum fragariae*, and *Colletotrichum gloeosporioides*, but did not show antimicrobial activity against *S. aureus, E. coli, S. abony, P. aeruginosa, or C. albicans* (Singh et al., 2012). Similarly, the thujone-rich essential oil from Uttarakhand was active against plant pathogenic fungi *Rhizoctonia solani, Sclerotium rolfsii*, and *Macrophomina phaseolina* (Jaitak et al., 2008). Another essential oil sample from Uttarakhand [major components: linalool (16.3%), thujone (13.9%), caryophyllene (7.5%), germacrene D (7.1%)] did show notable antibacterial activity against *S. aureus* and *P. aeruginosa* with MIC values of 6.25 and 12.5 g/mL, respectively (Sah et al., 2010). Traditional medical practitioners in Darjeeling, West Bengal, India, chew shoots of the plant to treat oral ulcers and apply crushed leaves to the forehead for dizziness and headaches (Jaitak et al., 2008). Inhabitants of the Parvati Valley, Himachal Pradesh, India, make a paste from the leaves and apply it cuts and wounds to check bleeding (Stappen et al., 2014). The antimicrobial activities of *A. nilagrica* are consistent with the traditional uses of the plant for wounds and ulcers.

**Table 1.** Major essential oil components of different species of *Artemisia*

| **Plant species (Family)** | **Major essential oil components** |
|---|---|
| *Artemisia dracunculus* L. (Asteraceae) | Aerial parts essential oil from Shansha, Kirting (Himachal Pradesh), India: capillene (58.4%), (Z) ocimene (8.6%), phellandrene (7.0%), terpinolene (5.9%). Leaf oil sample from Sanat Nagar, (Jammu and Kashmir), India: acenaphthene (51.7%), capillene (12.6%), (Z) ocimene (12.2%). Stem: acenaphthene (32.6%), capillene (34.7%), (Z)-ocimene (17.6%). Root: acenaphthene (66.6%), capillene (22.8%). Aerial parts essential oil from Kashmir, India: capillene (60.2%), (Z)-β-ocimene (12.7%), 5-phenyl-1,3-pentadiyne (5.1%). |
| *Artemisia dubia* Wall. ex Besser (Asteraceae) | Leaf oil sample from Kirtipur, Kathmandu, Nepal: chrysanthenone (29.0%), coumarin (18.3%), and camphor (16.4%). |
| *Artemisia gmelinii* Weber ex Stechm. (Asteraceae) | Aerial parts essential oil from a sample from Malari, Garhwal region, India: artemisia ketone (28.2%), 1,8-cineole (13.0%), sabinene (6.6%). Essential oil from the aerial parts of a sample from Niti Valley, Uttarakhand, India: artemisia ketone (53.3%), α-thujone (9.9%), 1,8-cineole (6.6%). Essential oil from the aerial parts of a sample from Jhelum, Uttarakhand, India: artemisia ketone (40.9%), α-thujone (4.0%), ar-curcumene (8.5%). |
| *Artemisia indica* Willd. (Asteraceae) | Leaf oil sample from Dhulikhel, Kavre, Nepal: ascaridole (15.4%), isoascaridole (9.9%), trans-p-mentha-2,8-dien-1-ol (9.7%), and trans-verbenol (8.4%). Aerial parts essential oil from Daksum, Kokerrnag (Kashmir), India: artemisia ketone (42.1%), germacrene B (8.6%), borneol (6.1%) and cis-chrysanthenyl acetate (4.8%). Aerial parts essential oil from Garhwal Himalaya, Uttarakhand, India: davanone (30.8%), α-pinene (15.3%), germacrene D (5.8%). |
| *Artemisia japonica* Thunb. (Asteraceae) | Aerial parts essential oil from Uttarakhand: linalool (27.5%), germacrene D (11.2%), (E)-β-ocimene (6.5%), 1,8-cineole (5.5%), (Z)-β-ocimene (5.5%). |
| *Artemisia maritima* L. (Asteraceae) | Aerial parts essential oil from a sample from Malari, Garhwal region, India: thujone (63.3%), sabinene (7.8%), 1,8-cineole (6.5%). |

| | |
|---|---|
| | Aerial parts essential oil from Pooh, Himachal Pradesh, India: 1,8-cineole (23.8%), chrysanthenone (17.5%).<br>Aerial parts essential oil from Rhongtong Pass, Himachal Pradesh, India: 1,8-cineole (37.3%), chrysanthenone (38.1%).<br>Aerial parts essential oil from Lahaul-Spiti, Himachal Pradesh, India: 1,8-cineole (44.2%), camphor (9.2%), borneol (10.9%).<br>Essential oil from the aerial parts growing in Chamoli district of Garhwal (Uttarakhand), India: 1,8-cineole (23.6%), chrystanthenone (25.7%), germacrene D (6.7%).<br>Aerial parts essential oil from Lahaul-Spiti, Himachal Pradesh, India: 1,8-cineole (27.2%), camphor (44.4%), camphene (5.9%). |
| *Artemisia nilagirica* (C.B. Clarke) Pamp. (Asteraceae) | Aerial parts essential oil from Lahaul-Spiti, Himachal Pradesh, India: Aerial parts: camphor (12.6%), artemisia ketone (10.2%), caryophyllene oxide (7.4%), borneol (5.3%).<br>Aerial parts essential oil from Uttarakhand, India: thujone (36.4%), thujone (9.4%), germacrene D (6.3%), terpinen-4-ol (6.3%).<br>Aerial parts essential oil from Garhwal region (Uttarakhand), India (500 m asl): thujone (36.9%), thujone (8.2%), terpinen-4-ol (7.1%).<br>Aerial parts essential oil from Garhwal region (Uttarakhand), India (1200 m asl): mequinyl p-nitrobenzoate (22.1%), eudesmol (12.4%), caryophyllene (7.4%).<br>Aerial parts essential oil from Garhwal region (Uttarakhand), India (2000 m asl):<br>linalool (32.5%), isopulegyl acetate (20.7%), sabinene (6.6%), caryophyllene (6.5%).<br>Leaf oil from Mandi (1044 m asl), Himachal Pradesh, India: caryophyllene oxide (28.6%), methanoazulene (10.9%).<br>Leaf oil from Manali (2050 m asl), Himachal Pradesh, India: borneol (35.8%), methanozaulene (14.7%), caryophyllene oxide (13.4%).<br>Leaf oil from Shimla (2210 m asl), Himachal Pradesh, India: camphor (46.9%), caryophyllene (13.3%), humulene (9.7%). |
| *Artemisia parviflora* Buch.-Ham. ex D. Don (Asteraceae) | Aerial parts essential oil from Kumaun (Uttarakhand), India: germacrene D (41.01%), caryophyllene (10.58%), humulene (7.86%).<br>Aerial parts from Pauri, Pauri Garhwal (Uttarakhand), India: caryophyllene (15.3%), germacrene D (14.7%), camphor (11.4%), artemisia ketone (7.8%), 1,8-cineole (5.8%). |
| *Artemisia roxburghiana* Besser (Asteraceae) | Aerial parts essential oil from a sample from Kedarnath, Garhwal region, India: thujone (65.3%).<br>Essential oil from aerial parts of plants cultivated in Italy from seeds collected in Khumbu Valley, Nepal: 1,8-cineole (16.6%), camphor (15.2%) thujone (10.0%).<br>Aerial parts essential oil from Mussoorie (Uttarakhand), India: borneol (21.2%), linalyl acetate (7.4%), humulene (6.7%).<br>Aerial parts essential oil from Bhatwari (Uttarakhand), India: caryophyllene (16.3%), thujone (12.0%).<br>Aerial parts essential oil from Bhaldana (Uttarakhand), India: caryophyllene (18.4%), eugenol (16.2%). |
| *Artemisia scoparia* Waldst. and Kit. (Asteraceae) | Aerial parts essential oil from Uttarakhand, India: capillene (42.1%), caryophyllene (12.5%), myrcene (9.2%), pinene (8.6%),<br>p cymene (6.8%), -terpinene (5.3%), 1-phenyl-2,4-pentadiyne (1.1%).<br>Leaf oil from Milam Glacier, Uttarakhand, India: capillene (60.2%), terpinene (11.1%), 1-phenyl-2,4-pentadiyne (1.0%); root oil: capillene (82.9%), 1-phenyl-2,4-pentadiyne (2.6%).<br>Aerial parts essential oil from Tajikistan: pinene (21.3%), 1-phenyl-2,4-pentadiyne (34.2%), myrcene (5.2%), capillene (4.9%). |
| *Artemisia vulgaris* L. (Asteraceae) | Leaf essential oil from Hetauda Makwanpur, Nepal: thujone (30.5%), 1,8-cineole (12.4%), and camphor (10.3%). |

***Artemisia parviflora***

*Artemisia parviflora* is widely distributed in the Himalayas between about 900 and 3500 m asl (Gupta et al., 2010). In the traditional medicine of the Kumaun Himalaya, the leaves of *A. parviflora* are used to treat skin diseases, burns, cuts, and wounds, while the volatiles from the plant are used to repel insects (Mehra et al., 2014).

The indigenous peoples of Jammu and Kashmir (India) use *A. parviflora* as a diuretic and also to treat gynaecological disorders (Semwal et al., 2015). The plant is also used in ethnoveterinary medicine as an anthelmintic; a decoction of the leaves and buds of the plant are given to stock animals (e.g., horses, mules, sheep, and buffaloes) for roundworm (Kumari et al., 2009). The plant is also used as a fodder plant in the mid-altitude rangelands of Uttarakhand (Singh et al., 2008). The essential oil from the aerial parts of *A. parviflora* collected from Pauri, Pauri Garhwal (Uttarakhand, India) was found to contain caryophyllene (15.3%), germacrene D (14.7%), camphor (11.4%), artemisia ketone (7.8%), and 1,8-cineole (5.8%) (Haider et al., 2010). There are apparently no reports on the bioactivities of Himalayan *A. parviflora* essential oil, but the oil from southern India has shown antifungal activity against *Candida* and *Cryptococcus* species (Ahuja et al., 2011).

***Artemisia roxburghiana***

People living in the Kedarnath Wildlife Sanctuary in the western Himalaya of Chamoli-Rudraprayag (Uttarakhand), India, use an extract of the whole plant to relieve fever (Bhat et al., 2013). In addition, the plant extract is rubbed on the skin to treat allergic reactions. In Jammu and Kashmir, India, *A. roxburghiana* is also used to treat skin allergies (Gairola et al., 2014). In northern Pakistan, an extract of the whole *A. roxburghiana* plant is used to treat fever and malaria; a powder of the whole plant is taken for intestinal worms (Ashraf et al., 2010). Indigenous people living in the Khyber Pakhtunkhwa Province of Pakistan use the leaves of *A. roxburghiana* to treat chest cold, sore throat, and toothache (Adnan et al., 2012). *A. roxburghiana* is used in ethnoveterinary medicine in Uttarakhand, India, to treat eye diseases, wounds, cuts, and external parasites (Pande et al., 2007).

As seen with other *Artemisia* species, there is a wide variation in the essential oil compositions of *A. roxburghiana*, and some of these variations can be attributed to altitude (Kumar et al., 2023). The essential oil of *A. roxburghiana* from Bhaldana, Uttarakhand (850 m asl) had caryophyllene (18.4%) and eugenol (16.2%) as the major components, while the oil from Bhatwari, Uttarakhand (1218 m asl) had caryophyllene (16.3%) and thujone (12.0%) as major components and the major components of the essential oil from Mussoorie, Uttarakhand (2205 m asl) were borneol (21.2%), linalyl acetate (7.4%), and humulene (6.7%) (Bicchi et al., 1998). Conversely, *A. roxburghiana* oil from Kedarnath, Uttarakhand (3200 m asl) was dominated by thujone (65.3%) (Mathela et al., 1994). *A. roxburghiana*, plants were grown in Garniga, Trento, Italy (800 m asl), from seeds that were collected between 2600 and 4600 in the Khumbu Valley of Nepal. The essential oil from these plants was rich in 1,8-cineole (16.6%), camphor (15.2%), and thujone (10.0%) (Rana et al., 2003). Apparently, there have been a few reports on the biological activities of Himalayan *A. roxburghiana* essential oils, and it is difficult to draw any correlations between ethnobotanical use and phytochemical compositions with such wide variations in their compositions (Kumar et al., 2019; Kumar et al., 2022).

***Artemisia scoparia***

*Artemisia scoparia* (syn. *A. capillaris*) is widespread and common throughout southwest Asia and central Europe. The aerial parts of *A. scoparia* yield an essential oil with medicinal properties, and has been reported to possess insecticidal, antioxidant, antibacterial, anticholesterolemic, antipyretic, antiseptic, cholagogue, diuretic, purgative and vasodilatatory activities (Bora and Sharma, 2011). *A. scoparia* essential oils are generally rich in diacetylenes. Thus, the leaf oil of *A. scoparia* collected from Milam glacier, Uttarakhand, India, was composed of capillene (60.2%), α-terpinene (11.1%), and 1-phenyl-2,4-pentadiyne (1.0%), while the root essential oil was dominated by capillene (82.9%) and 1-phenyl-2,4-pentadiyne (2.6%) (Joshi et al., 2010). In contrast, the essential oil from the aerial parts of *A. scoparia* cultivated in New Delhi was composed largely of myrcene (24.4%), -terpinene (18.3%), p-cymene (17.4%), and neral (12.5%) (Kapoor et al., 2004), while *A. scoparia* essential oil from Tajikistan was made up of pinene (21.3%), 1-phenyl-2,4-pentadiyne (34.2%), myrcene (5.2%), and capillene (4.9%) (Sharopov and Setzer, 2011). A capillene-rich (42.1%) essential oil of *A. scoparia* from Uttarakhand showed excellent antibacterial activity against *S. aureus* and *B. subtilis* with MIC values of 12.5 g/mL (Semwal et al., 2015).

Inhabitants of the Nanda Devi National Park, Uttarakhand, India, apply a paste of the leaves of *A. scoparia* on cuts and wounds (Rana et al., 2010). The leaf powder is taken to treat diabetes and as a blood purifier, to treat abdominal complaints, colic, cough, and cold. People in the Agra Valley, Parachinar, Pakistan, use the whole plant of *A. scoparia* to treat burns, jaundice, and earache; the volatiles of the plant are inhaled for chest congestion (Ajaib et al., 2014). The biological activities of *A. scoparia* and its essential oils are likely due to capillene. This compound has shown antibacterial and antifungal activities (Yashina and Vereshchagin, 1978; Christensen, 2010).

***Artemisia vulgaris***

*Artemisia vulgaris* is used in Nepal to treat various ailments (Gaire and Subedi, 2011). The crushed leaves are inserted into the nose to stop bleeding. A bath prepared with crushed leaves is used to treat allergic reactions. Raw leaves are chewed as a treatment for oral ulcers. In northern Pakistan, the leaf extract of *A. vulgaris* is used to treat malaria and fevers (Ashraf et al., 2010). In Sudhan Gali, Kashmir, Pakistan, an extract of the leaves is used for the treatment of ophthalmic diseases (Waseem et al., 2006). The leaf essential oil of *A. vulgaris*, collected from Hetauda Makwanpur, Nepal, was found to contain thujone (30.5%), 1,8-cineole (12.4%), and camphor (10.3%) (Satyal et al., 2012). This essential oil was screened for antimicrobial activity against *B. cereus, S. aureus, E. coli, P. aeruginosa* and *A. niger*, but was found to be inactive (MIC = 2500 μg/mL). Another *A. vulgaris* essential oil sample from Nepal did exhibit antibacterial activity against *Streptococcus pyogenes* and *Propionibacterium acnes* (Bhatt et al., 2006). Some major constituents of the essential oils of different *Artemisia* species are given in Table 1.

**CONCLUSION**

The Himalayas, with wide-ranging elevations, deep glacial and river valleys, areas of high rainfall and areas of high desert, is a rich area of biodiversity with much endemism. Traditional herbal medicine continues to play a role in many tribal areas, and numerous medicinal plants and their essential oils have shown remarkable biological activities. Unfortunately, there remains a paucity of information relating the biological activities of essential oils with the ethnobotanical uses of the plants. In many cases, this may be due to the activity residing in non-volatile components. Additionally, many phytochemical researchers have neglected bioactivity screening related to ethnopharmacological uses. Thus, there is much additional work that can be carried out to identify phytochemicals associated with biological activities that support traditional uses of medicinal plants. In addition, several aromatic plants have shown commercial promise as flavouring agents, fragrances, cosmetics, and pesticides. Due, in part, to the great demand for essential oils, herbal medicines, and pharmaceuticals, the medicinal plants of the Himalayas are threatened by unsustainable harvesting, increasing environmental degradation, invasive plant species and climate change. It is an urgent need to encourage the preservation of traditional knowledge and uses of Himalayan medicinal plants and additional steps are required undertaken to protect and maintain the Himalayan ecology.

## CONFLICTS OF INTEREST

The author(s) declare(s) no conflicts of interest.

## DECLARATION

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## REFERENCES


Abad MJ, Bedoya LM, Apaza L, Bermejo P (2012). The Artemisia L. genus: A review of bioactive essential oils. Molecules, 17, 2542-2566. https://doi.org/10.3390/molecules17032542

Adnan M, Begum S, Khan AL, Tareen AM, Lee IJ (2012). Medicinal plants and their uses in selected temperate zones of Pakistani Hindukush-Himalaya. Journal of Medicinal Plants Research, 6, 4113-4127. https://doi.org/10.5897/JMPR12.656

Ahuja J, Suresh J, Paramakrishnan N, Mruthunjaya K, Naganandhini MN (2011). An ethnomedical, phytochemical and pharmacological profile of Artemisia parviflora Roxb. Journal of Essential Oil Bearing Plants, 14, 647-657. https://doi.org/10.1080/0972060X.2011.10643985

Ajaib M, Haider SK, Zikrea A, Siddiqui MF (2014). Ethnobotanical studies of herbs of Agra Valley, Parachinar, Upper Kurram Agency, Pakistan. International Journal of Biology and Biotechnology, 11, 71-83.

Albert-Puleo, Mythobotany M (1978). Pharmacology, and chemistry of thujone-containing plants and derivatives. Economic Botany, 32, 65-74. https://doi.org/10.1007/BF02906731

Ashraf M, Hayat MQ, Jabeen S, Shaheen N, Khan MA, Yasmin G (2010). Artemisia L. species recognized by the local community of northern areas of Pakistan as folk therapeutic plants. Journal of Medicinal Plants Research, 4, 112-119.

Badoni R, Semwal DK, Rawat U (2009). Altitudinal variation in the volatile constituents of Artemisia nilagirica. International Journal of Essential Oil Therapeutics, 3, 66–68.

Badoni R, Semwal DK, Rawat U (2010). Composition variation in essential oils of Artemisia nilagirica and Artemisia capillaris, growing in India. Journal of Applied and Natural Science, 2(1), 30-33. https://doi.org/10.31018/jans.v2i1.90

Balami NP (2004). Ethnomedicinal uses of plants among the Newar community of Pharping village of Kathmandu district, Nepal. Tribhuvan University Journal, 24, 13-19. https://doi.org/10.3126/tuj.v24i1.251

Barthlott W, Mutke J, Rafiqpoor D, Kier G, Kreft H (2005). Global centers of vascular plant diversity. Nova Acta Leopoldina, 92, 61-83.

Bhat JA, Kumar M, Bussmann RW (2013). Ecological status and traditional knowledge of medicinal plants in Kedarnath Wildlife Sanctuary of Garhwal Himalaya, India. Journal of Ethnobiology and Ethnomedicine, 9, 1. https://doi.org/10.1186/1746-4269-9-1

Bhatt LR, Lim JA, Chai KY, Kang JI, Oh HK, Baek SH (2006). Antioxidative and antimicrobial activities of essential oil from Artemisia vulgaris. Natural Product Sciences, 12, 226-231.

Bicchi C, Rubiolo P, Marschall H, Weyerstahl P, Laurent R (1998). Constituents of Artemisia roxburghiana Besser essential oil. Flavour and Fragrance Journal, 13, 40-46. https://doi.org/10.1002/(SICI)1099-1026(199801/02)13:1<40::AID-FFJ688>3.0.CO;2-Z

Bora KS, Sharma A (2011). The genus Artemisia: A comprehensive review. Pharmaceutical Biology, 49, 101-109. https://doi.org/10.3109/13880209.2010.497815

Caius JF, Mhaskar KS (1923). The correlation between the chemical composition of anthelmintics and their therapeutic values in connection with the hookworm inquiry in the Madras presidency. XIX. Drugs allied to thymol. Indian Journal of Medical Research, 11, 337-346.

Chauhan RS, Kitchlu S, Ram G, Kaul MK, Tava A (2010). Chemical composition of capillene chemotype of Artemisia dracunculus L. from north-west Himalaya, India. Industrial Crops and Products, 31, 546-549. https://doi.org/10.1016/j.indcrop.2010.02.005

Christensen LP (2010). Bioactivity of polyacetylenes in food plants. In Bioactive Food in Promoting Health: Fruits and Vegetables; Watson, R.R., Preedy, V.R., Eds.; Academic Press: London, UK, pp. 285-306. https://doi.org/10.1016/B978-0-12-374628-3.00020-7

Devi U, Seth MK, Sharma P, Rana JC (2013). Study on ethnomedicinal plants of Kibber Wildlife Sanctuary: A cold desert in Trans Himalaya, India. Journal of Medicinal Plants Research, 7, 3400-3419.

Gaire BP, Subedi L (2011). Medicinal plant diversity and their pharmacological aspects of Nepal Himalayas. Pharmacognosy Journal, 3, 6-17. https://doi.org/10.5530/pj.2011.25.2

Gairola S, Sharma Y, Bedi YS (2014). A cross-cultural analysis of Jammu, Kashmir and Ladakh (India) medicinal plant use. Journal of Ethnopharmacology, 155, 925-986. https://doi.org/10.1016/j.jep.2014.06.029

Gupta RC, Himshikha Rana PK, Kumar P, Singhal VK (2010). First report of structural heterozygosity in Artemisia parviflora (Asteraceae) from Parvati Valley in Kullu district (Himachal Pradesh, India). Botanica Serbica, 34, 63-66.

Haider F, Kumar N, Naqvi AA, Bagchi GD (2010). Oil constituents of Artemisia nilagirica var. septentrionalis growing at different altitudes. Natural Product Communications, 5, 1959-1960. https://doi.org/10.1177/1934578X1000501227

Haider SZ, Andola HC, Mohan M (2012). Constituents of Artemisia gmeliniiWeber ex Stechm. from Uttarakhand Himalaya: A source of artemisia ketone. Indian Journal of Pharmaceutical Sciences, 74, 265-267. https://doi.org/10.4103/0250-474X.106074

Haider SZ, Mohan M, Andola HC (2014). Constituents of Artemisia indica Willd. from Uttarakhand Himalaya: A source of davanone. Pharmacognosy Research, 8, 257-259. https://doi.org/10.4103/0974-8490.132607

Hara H, Chater AO, Williams HJ (1982). An Enumeration of the Flowering Plants of Nepal; British Museum of Natural History: London, UK, Volume III.

Hara H, Stearn WT, Williams HJ (1978). An Enumeration of the Flowering Plants of Nepal; British Museum of Natural History: London, UK, Volume I.

Hara H, Williams HJ (1979). An Enumeration of the Flowering Plants of Nepal; British Museum of Natural History: London, UK, Volume II.

Höld KM, Sirisoma NS, Ikeda T, Narahashi T, Casida JE (2000). Thujone (the active component of absinthe): -Aminobutyric acid type A receptor modulation and metabolic detoxification. Proceedings of the National Academy of Sciences, 97, 3826-3831.
https://doi.org/10.1073/pnas.070042397

Jaitak V, Singh B, Kaul VK (2008). Variability of volatile constituents in Artemisia maratima in western Himalaya. Natural Product Research, 22, 565-568.
https://doi.org/10.1080/14786410701592653

Jalizadeh-Amin G, Maham M (2015). The application of 1,8-cineole, a terpenoid oxide present in medicinal plants, inhibits castor oil-induced diarrhea in rats. Pharmaceutical Biology, 53, 594-599.
https://doi.org/10.3109/13880209.2014.935862

Joshi RK (2015). Volatile oil composition of Artemisia japonica Thunb. from western Himalaya of Uttarakhand. Journal of Pharmacognosy and Phytochemistry, 3, 96-97.

Joshi RK, Padalia RC, Mathela CS (2010). Phenyl alkynes rich essential oil of Artemisia cappillaris. Natural Product Communications, 5, 815-816.
https://doi.org/10.1177/1934578X1000500528

Kapoor R, Ali M, Mir SR, Rafiullah MRM (2004). Essential oil constituents of aerial parts of Artemisia scoparia Waldst. & Kit. Flavour and Fragrance Journal, 19, 109-111.
https://doi.org/10.1002/ffj.1278

Klayman DL (1985). Qinghaosu (artemisinin): An antimalarial drug from China. Science, 228, 1049-1055.
https://doi.org/10.1126/science.3887571

Köppel C, Tenczer J, Shirop T, Ibe K (1982). Camphor poisoning-Abuse of camphor as a stimulant. Archives of Toxicology, 51, 101-106.
https://doi.org/10.1007/BF00279325

Kumar A, Aswal S, Chauhan A, Semwal RB, Singh R, Andola HC, Joshi SK, Semwal DK (2022). Antidiabetic effect of aqueous-ethanol extract from the aerial parts of Artemisia roxburghiana. Natural Product Research, 36(5), 1300-1305.
https://doi.org/10.1080/14786419.2020.1858414

Kumar A, Aswal S, Semwal RB, Chauhan A, Semwal DK (2019). Insights on the pharmacological, phytochemical and ethnobotanical aspects of Artemisia roxburghiana: a rather less explored but therapeutically important species of lower Himalayas. Phytochemistry Reviews, 18, 199-214.
https://doi.org/10.1007/s11101-018-9589-6

Kumar A, Semwal R, Chauhan A, Semwal RB, Andola HC, Joshi SK, Semwal DK (2023). Microscopic identification, GC-MS analysis of essential oil and antioxidant activity of Artemisia roxburghiana. Journal of Current Science and Technology, 13(1), 36-45.
https://doi.org/10.14456/jcst.2023.4

Kumar GP, Gupta S, Murugan MP, Singh SB (2009). Ethnobotanical studies of Nubra Valley-A cold arid zone of Himalaya. Ethnobotanical Leaflets, 13, 752-765.

Kumar M, Paul Y, Anand VK (2009). An ethnobotanical study of medicinal plants used by the locals in Kishtwar, Jammu and Kashmir, India. Ethnobotanical Leaflets, 13, 1240-1256.

Kumari P, Singh BK, Joshi GC, Tewari LM (2009). Veterinary ethnomedicinal plants in Uttarakhand Himalayan Region, India. Ethnobotanical Leaflets, 13, 1312-1327.

Kunwar RM, Adhikari N (2005). Ethnomedicine of Dolpa district, Nepal: The plants, their vernacular names and uses. Lyonia, 8, 43-49.

Lachenmeier DW, Walch SG, Padosch SA, Kröner LU (2006). Absinthe-A review. Critical Reviews in Food Science and Nutrition, 46, 365-377.
https://doi.org/10.1080/10408690590957322

Mabberley, D.J. Mabberley's Plant-Book, 3rd ed.; Cambridge University Press: Cambridge, UK, 2008.

Mathela CS, Kharkwal H, Shah GC (1994). Essential oil composition of some Himalayan Artemisia species. Journal of Essential Oil Research, 6, 345-348.
https://doi.org/10.1080/10412905.1994.9698397

Mehra A, Bajpai O, Joshi H (2014). Diversity, utilization and sacred values of ethno-medicinal plants of Kumaun Himalaya. Tropical Plant Research, 1, 80-86.

Mir F, Rather MA, Dar BA, Rasool S, Shawl AS, Alam MS, Qurishi MA (2012). Comparative GC-FID and GC-MS analysis of the chemical profile of the leaf, stem and root essential oils of Artemisia dracunculus L. growing in Kashmir (India). Journal of Pharmacy Research, 5, 1353-1356.

Obolskiy D, Pischel I, Feistel B, Glotov N, Heinrich M (2011). Artemisia dracunculus L. (tarragon): A critical review of its traditional use, chemical composition, pharmacology and safety. Journal of Agricultural and Food Chemistry, 59, 11367-11384.
https://doi.org/10.1021/jf202277w

Pande PC, Tiwari L, Pande HC (2007). Ethnoveterinary plants of Uttaranchal-A review. Indian Journal of Tradititional Knowledge, 6, 444-458.

Patra C, Sarkar S, Dasgupta MK, Das A (2015). Camphor poisoning: An unusual cause of seizure in children. Journal of Pediatric Neurosciences, 10, 78-79.

Rana CS, Sharma A, Kumar N, Dangwal LR, Tiwari JK (2010). Ethnopharmacology of some important medicinal plants of Nanda Devi National Park (NDNP) Uttarakhand, India. Nature and Science, 8, 9-14.

Rana VS, Juyal JP, Blazquez MA, Bodakhe SH (2003). Essential oil composition of Artemisia parviflora aerial parts. Flavour Fragr. J., 18, 342-344.
https://doi.org/10.1002/ffj.1239

Rashid S, Rather MA, Shah WA, Bhat BA (2013). Chemical composition, antimicrobial, cytotoxic and antioxidant activities of the essential oil of Artemisia indica Willd. Food Chemistry, 138, 693-700.
https://doi.org/10.1016/j.foodchem.2012.10.102

Rashmi TR, Francis MS, Soumya M (2014). Essential oil composition of Artemisia japonica Thunb. from Kerala. J. Pharmacogn. Phytochem., 3, 160-163.

Rokaya MB, Münzbergová Z, Timsina B (2010). Ethnobotanical study of medicinal plants from the Humla district of western Nepal. Journal of Ethnopharmacology, 130, 485-504.
https://doi.org/10.1016/j.jep.2010.05.036

Sah S, Lohani H, Narayan O, Bartwal S, Chauhan NK (2010). Volatile constituents of Artemisia maritima Linn. grown in Garhwal Himalaya. Journal of Essential Oil Bearing Plants, 13, 603-606.
https://doi.org/10.1080/0972060X.2010.10643869

Samant SS, Dhar U, Palni LMS (1998). Medicinal Plants of Indian Himalaya: Diversity, Distribution Potential Values. Gyanodaya Prakashan, Nainital, India, p. 163.

Samant SS, Dhar U, Palni LMS (2011). Medicinal Plants of Indian Himalaya: Diversity Distribution Potential Values; G.B. Pant Institute of Himalayan Environment and Development: Almora, India.

Samant SS, Pant S, Singh M, Lal M, Singh A, Sharma A, Bhandari S (2007). Diversity, distribution pattern, indigenous uses and conservation prioritization of medicinal plants of Himachal Pradesh, India. International Journal of Biodiversity Science and Management, 3, 234-251.
https://doi.org/10.1080/17451590709618177

Santos FA, Rao VSN (2001). 1,8-Cineole, a food flavoring agent, prevents ethanol-induced gastric injury in rats. Digestive Diseases and Sciences, 46, 331-337.
https://doi.org/10.1023/A:1005604932760

Santos FA, Silva RM, Campos AR, de Araújo RP, Lima-Júnior RCP, Rao VSN (2004). 1,8-Cineole (eucalyptol), a monoterpene oxide attenuates the colonic damage in rats on acute TNBS-colitis. Food and Chemical Toxicology, 42, 579-584.
https://doi.org/10.1016/j.fct.2003.11.001

Satyal P, Paudel P, Kafle A, Pokharel SK, Lamichhane B, Dosoky NS, Moriarity DM, SetzerWN (2012). Bioactivities of volatile components from Nepalese Artemisia species. Natural Product Communications, 7, 1651-1658. https://doi.org/10.1177/1934578X1200701228

Semwal RB, Semwal DK, Mishra SP, Semwal R (2015). Chemical composition and antibacterial potential of essential oils from Artemisia cappillaris, Artemisia nilagirica, Citrus limon, Cymbopogon flexuosus, Hedychium spicatum and Ocimum tenuiflorum. Natural Products Journal, 5, 199-205. https://doi.org/10.2174/2210315505666150827213344

Setzer WN, Vogler B, Schmidt JM, Leahy JG, Rives R (2004). Antimicrobial activity of Artemisia douglasiana leaf essential oil. Fitoterapia, 75, 192-200. https://doi.org/10.1016/j.fitote.2003.12.019

Shah AJ, Gilani AH, Abbas K, Rasheed M, Ahmed A, Ahmad VU (2011). Studies on the chemical composition and possible mechanisms underlying the antispasmodic and brochodilatory activities of the essential oil of Artemisia maritima L. Archives of Pharmacal Research, 34, 1227-1238. https://doi.org/10.1007/s12272-011-0801-0

Sharma PK, Chauhan NS, Lal B (2004). Observations on the traditional phytotherapy among the inhabitants of Parvati valley in western Himalaya, India. Journal of Ethnopharmacology, 92, 167-176. https://doi.org/10.1016/j.jep.2003.12.018

Sharopov FS, Setzer WN (2011). The essential oil of Artemisia scoparia from Tajikistan is dominated by phenyldiacetylenes. Natural Product Communications, 6, 119-122. https://doi.org/10.1177/1934578X1100600128

Singh DK, Hajra PK (1996). Floristic diversity. In Changing Perspective of Biodiversity Status in the Himalaya; Gujral, G.S., Sharma, V., Eds.; British Council Division, British High Commission Publication, Wildlife Youth Services: New Delhi, India, pp. 23-38.

Singh KN, Lal B, Todaria NP (2012). Ethnobotany of higher plants in Spiti Cold Desert of western Himalaya. Nature and Science, 10, 7-14.

Singh V, Chauhan NS (2005). Traditional practices of herbal medicines in the Lahaul valleys, Himachal Himalayas. Indian Journal of Trademark Knowledge, 4, 208-220.

Singh V, Gaur RD, Bohra B (2008). A survey of fodder plants in mid-altitude Himalayan rangelands of Uttarakhand, India. Journal of Mountain Science, 5, 265-278. https://doi.org/10.1007/s11629-008-0170-4

Srivastava TN, Rajasekharan S, Badola DP, Shah DC (1986). An index of the available medicinal plants, used in Indian system of medicine from Jammu and Kashmir State. Ancient Science of Life, 6, 49-63.

Stappen I, Wanner J, Tabanca N, Wedge DE, Ali A, Khan IA, Kaul VK, Lal B, Jaitak V, Gochev V (2014). Chemical composition and biological effects of Artemisia maritima and Artemisia nilagirica essential oils from wild plants of western Himalaya. Planta Medica, 80, 1079-1087. https://doi.org/10.1055/s-0034-1382957

Uprety Y, Asselin H, Boon EK, Yadav S, Shrestha KK (2010). Indigenous use and bio-efficacy of medicinal plants in the Rasuwa District, central Nepal. Journal of Ethnobiology and Ethnomedicine, 6, 3. https://doi.org/10.1186/1746-4269-6-3

Uprety Y, Poudel RC, Asselin H, Boon E (2011). Plant biodiversity and ethnobotany inside the projected impact area of the Upper Seti Hydropower Project, western Nepal. Environment, Development and Sustainability, 13, 463-492. https://doi.org/10.1007/s10668-010-9271-7

Ved DK, Goraya GS (2007). Demand and Supply of Medicinal Plants in India. NMPB, New Delhi & FRLHT, Bangalore, India.

Verma M, Anand R, Chisti AM, Kitchlu S, Chandra S, Shawl AS, Khajuria RK (2010). Essential oil composition of Artemisia dracunculus L. (tarragon) growing in Kashmir-India. Journal of Essential Oil Bearing Plants, 13, 331-335. https://doi.org/10.1080/0972060X.2010.10643830

Waseem M, Shah MAU, Qureshi RA, Muhammad I, Afza R, Yousaf S (2006). Ethnopharmacological survey of plants used for the treatment of stomach, diabetes, and ophthalmic diseases in Sudhan Gali, Kashmir, Pakistan. Acta Botanica Yunnanica, 28, 535-542.

Winward AH (1980). Taxonomy and Ecology of Sagebrush in Oregon; Agricultural Experiment Station, Oregon State University: Corvallis, OR, USA.

Yashina OG, Vereshchagin LI (1978). Natural and synthetic acetylenic antimycotics. Russian Chemical Reviews, 47, 307-317. https://doi.org/10.1070/RC1978v047n03ABEH002220

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