



The Economic and Medicinal *Artemisia* species in India.

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Abstract

The *Artemisia* species of India are discussed in to two groups; i. The species found in the Northern plains and in the Peninsular region including Western Ghats, etc. ii. *Artemisia* species found in the Indian Himalayas. The present paper is based mainly on three main publications, on taxonomy of *Artemisia*; Kaul & Bakshi (1984), which had reported two new species, viz., *Artemisia banihalensis* Kaul & Bakshi. Sp. Nov. and *Artemisia cashemirica* Kaul & Bakshi. Sp. Nov. However, these species were not mentioned in the two papers, viz., Hazra *et al.* (1995) and , Karthikeyan *et al.* (2009). It further deals with the basis of separation of *Serephidium* species from the *Artemisia* genus. However, the chemo-taxonomy, Belenovskaja, (1996), in USSR, and molecular-taxonomy by Watson, (1996), do not confirm and support the separation of *Serephidium* from the genus *Artemisia*. The Ethnobotany of *Artemisia* and *Serephidium* species, is discussed with the indigenous traditional medicinal uses , i.e., Unani and Ayurveda, in India. The use as an incense and offering to the local deities only in Kumaon Himalayas, and use in the North Eastern region of the country. Not only this, the species used as an incense in Kumaon Himalayas are also supported with the chemical assay of the essential oils, extracted from the *Artemisia* species. The cultivation of the *Artemisia* species, either recorded in the past or which are presently, being cultivated is discussed. The species, which are recorded occurring wild within the country, in the Himalayas, and are being cultivated elsewhere, in other parts of the world but not in India, are discussed, in detail with their botany, distribution, parts used and with the miscellaneous uses. Further, the work on *Artemisia* species undertaken in Central Institute of Medicinal & Aromatic Plants, Lucknow during 1981 to 1986, which includes the survey of the wild growing *Artemisia* species to find the wild growing *Artemisia annua* within the country. The introduction of *A. annua* in India to produce artemisinin and other products to be used in cerebral malaria , etc. is discussed. Not only this, two new species recorded viz., *A. astro-himalayaca*, and *A. filiformilobulata* collected by the author are also communicated. Further, the *Artemisia* species, reported to be present in North-East India, and on which the ethnobotanical, chemical, work and assay of the essential oil present, are enumerated for future work.

Keywords: Ethnobotany; *Artemisia*; Medicinal & Aromatic Plants.

Introduction

The genus *Artemisia* of family *Asteraceae* (*Compositae*) is one of the largest and most complicated and difficult taxa to understand. Generic name 'Artemisia' is derived from 'Artemis', which refers to Diana, a Greek Goddess. The name of the Goddess 'Artemis' was given to the genus because one of the species *A. vulgaris*, L. was much used in medicine for women's disease in folk remedy (Takeda, 1971, Sr, No. 26). However, *Artemisia* species are used medicinally throughout the world, in Europe, in Middle East Countries, Afghanistan, Pakistan, India, China Korea, etc.

The taxonomic works so far been conducted in recent years were consulted. The taxa referred earlier, and mentioned in this text are equated to new valid botanical names. In India, *Artemisia* species are mainly used in traditional system of medicine, Unani-tibb and Ayurveda and ethnobotanically used as incense due to their sweet aromatic odour or as an offering to local deities. Not only this, the *Artemisia* species, which were either recorded to be cultivated in the past or are being cultivated, presently for monetary gains are discussed.

Further, the work on *Artemisia* species undertaken in Central Institute of Medicinal & Aromatic Plants, Lucknow during 1981 to 1986, by the author, which includes the survey of the wild growing *Artemisia* species from the border region of Tibet. Further, the *Artemisia* species, reported to be present in North-East India and on which, no ethnobotanical and chemical work including analysis of the essential oil, have been done are also enumerated.

***Artemisia* species in India :** As stated earlier, there are about 500 species of *Artemisia* reported in the world and out of which about 45 species, are found in India. However, Huang & Ling (1996) reported 200 species of *Artemisia* from China. From the author's collection at Herbarium

CIMAP, Lucknow. When the specimens were sent to Prof. Ling in China (without the knowledge of the author by Dr. H.S.Puri very secretly, when he was out on tour). Prof. Ling reported two new *Artemisia* species, from the authors collections. Further, the species of *Artemisia brevifolium*, which were collected from Malari by the author were raised to the generic level, i.e., *Serephidium brevifolium*.

It is expected up to now Prof. Ling might have discovered more than 40-45 new species of *Artemisia* from herbaria of China and from other parts of the world.

However, there are only a few *Artemisia* species, which have been collected and their essential oil has been assayed and out of these some are the cultivated ones like; *Artemisia pallens* and *A. annua*, the essential oils are well known and marketed and have a good demand. There are many others, growing in wild, the essential oils of which have not been worked out even on experimental scale and out of these most of them belong mainly to the North-Eastern Himalayas, and the ethnobotany(

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medicinal uses) of *A. annua* as used in China and Vietnam is discussed have not been yet worked out.

The Taxonomy and botany of *Artemisia* species in India : The earlier botanical and taxonomical studies on *Artemisia* species, in India, is available in, Roxburgh (1832), Hooker (1881), Bamber, (1916), Stewart, (1972), Rau (1975), etc. and from the regional floras brought out from time to time. Presently, *Artemisia* species found in India could be studied in two parts; i. The species found in the Northern plains, and in the Peninsular region including the Western Ghats. There are, only a few species, viz., *A. capillaries* Thunb. syn. *A. scoparia* found in Gujrat, Panjab, Upper Gangetic plains. *A. indica* Willd. and *A. nilagarica* (C.B. Clarke) Pamp. var. *nilagarica*, earlier reported as *A. vulgaris* L. is distributed in Mt Abu, Western Ghats, Nilguries, Karnataka, Deccan peninsula, Maharashtra, (Chopra et al 1956), Hazra et al, (1995); and *A. capillaries* Thunb. var. *scoparia* in Panjab and Indo-Gangetic plains and Bihar, (Chopra et al 1956, as *A. scoparia*) and Maharashtra, known as 'churisaraj'. Further, *A. carvifolia* Buch. Ham. reported to be distributed in the Gangetic plains. *A. myriantha* Wallich. ex Besser var. *pleocephala* (Pamp) Ling reported to be also distributed in Karnataka, Hazra et al, (1995).

ii. *Artemisia* species found in the Indian Himalayas are enumerated, by Stewart, (1972) from Kashmir Himalayas and Ladakh, and, from the high altitude region in the Western Himalayas, by Rau (1975), who enumerated total 13 species; Kaul & Bakshi, (1984) studied 20 species from Kashmir Himalayas, on the basis of chromosome numbers and morphological features, and had also reported two new species. Later,



A. capillaries Thunb. syn. *A. scoparia*. The species which is also found in Indo-Gangetic plains, Gujrat, Maharashtra, etc. It is not only used in medicine in India but also in Indo-China.

Hazra et al, (1995), described 32 species from India along with a Key and 15 line drawings. Recently, Karthikeyan et al, (2009) has reported 45 species of *Artemisia*, with their varieties, which were earlier either catalogued or reported. However, they had also separated the *Serephidium* from *Artemisia* species and enumerated 4 *Serephidium* species

found in India. Hazra et al., (1995) had not separated *Serephidium* from *Artemisia* species.

Furthermore, two new species reported by Kaul & Bakshi (1984), viz., *Artemisia banihalensis* Kaul & Bakshi, *sp. nov.* and *Artemisia cashemirica* Kaul & Bakshi, *sp. nov.* were not included by any of these workers. These species are well accepted in the Plant List (2010) (<http://www.theplantlist.org>).

Separation of *Serephidium* from *Artemisia*: Genus *Artemisia* is a complex and one of the most complicated genera in the tribe *Anthemidae* and it has been studied by many botanists in the past. Bessermmer in 1828 created a section *Serephidium* Bess (Bull. Soc. Nat. Mosc. 1:222, 1828 quoted by Ling (1980). Hooker (1881) and other taxonomists recognized four main sections of the genus *Artemisia*, viz., *Abrotanum*, *Absinthin*, *Dracunculous* and *Serephidium*. However, Poljakova in 1961 in Flora of USSR subdivided the subgenus into two main sections, *Junccein* and *Serephidium*. More recently, Ling (1981)

proposed that Tridentate taxa under section *Serephidium* should be subsumed into genus *Serephidium*, on the basis of some morphological characters and the genus *Serephidium* (Bess) Poljak. was separated from *Artemisia*, on the basis of the morphological characters, like heads being homogamous, flowers all fertile, stems, woody and heads being in centrifugal inflorescence, total flowers less than 6 and bracts 4-7 seriate, etc.

***Artemisia* and *Serephidium* in China:** As stated earlier, 200 species of *Artemisia* are found from China (where we have only about 40-45) out of which 45 sp. are reported to be medicinal and 15 used for other purposes like; food, forage, aromatics, etc., Huang & Ling (1996 as per Table no. 1- p.449). Similarly, 13 *Serephidium* species have been reported, Ling, (1986), out of which 3 used as medicinal and 3 as forage and 4 as aromatics, Huang & Ling (1996).

Chemo-taxonomy and Molecular-taxonomy: However, Belenovskaja, (1996) in USSR undertook study of herbarium samples on the widespread pattern of the flavonoids in different species of *Artemisia* to find the correlation between flavonoid pattern and the taxonomic positions. The flavonoid data do not confirm the separation of subgenus *Serephidium* from the genus *Artemisia*. Not only this, the molecular systematics, has also found that *Artemisia* and *Serephidium* are sister groups and these can not be separated, Watson, (1996).

***Artemisia* and *Serephidium* in India:** As stated earlier about -45 species and their varieties of *Artemisia* found in India and out of which, only 4 have been converted into *Serephidium* by Karthikeyan et al (2009).

Ethnobotany as Traditional medicinal uses in Europe and in Middle-East countries: A number of *Artemisia* species have been recorded from Europe right from the sea coast to alpine region to higher alps up to 2580 m. to 3700 m. like; *A. absinthium* (wormwood) and *A. mutelliana* and used medicinally in Europe, Huxley (1967). *A. maritima* is distributed in Europe near sea-shore that is why it was called *A. maritima*. In Europe, *A. dracuncululus* (Tarragon) and *A. abrotanum* (Southern wood or Lad's love) are used in medicine and for different purposes, (Stary & Jirasek, 1973).

While from Middle-East countries-7 *Artemisia* species, Belakdhar et al (1982); From Iran, Egypt and Morocco- 3 species, Ahmed et al., (1979); from Turkey- 6 species, Baser et al., (1986) are used medicinally. In Yemen, only *Artemisia absinthium* locally known as 'rihan' and the leaves are used medicinally as analgesic in childbirth and as a spasmolytic, and is well cultivated, Fleurentin and Pelt, (1982). Similarly, in Afghanistan, 3 species, viz., *A. absinthium*, known locally as 'afsanteen', 'marwa', 'mandaw' used in digestive disorders and as a carminative; *A. alba* L. locally known as 'sih', 'mastyar' and 'drano' used as an anti-pyretic, diuretic, and anthelmintic, and *A. cina* Berq., known as 'terx', 'terxa', 'kermbota', or 'kermak bota' used also as an anthelmintic. All these species grow wild in steppes from 700 m. to 1700 m. in Afghanistan, Younos, et al., (1987). In Pakistan, a survey of the Unani-tibb medicinal drugs sold by the drug dealers and their use was conducted, in which the following *Artemisia* species, viz., *A. absinthium*, *A. maritima*, *A. sieversiana*, *A. vulgaris* were found, Usmanghani, et al, (1986), such types of survey is also required in India.

The use of some of the *Artemisia* species was brought from the above stated countries into India by the Arabians, as we see below:

The use of *Artemisia* species in India: When the Arabian traders came to India in about 800 A.D. especially to Gujrat and Malabar coastal

region, they started colonizing these places and settled down here. They also brought with them their own Greco-Arabic system of medicine (Unani System of Medicine) for their own treatment and also introduced it, in India. They brought with them, a rich store of their own Materia-Medica quite unknown, in India. Possibly, earlier the *Artemisia* species they used medicinally, viz., *A. absinthium*, *A. maritima*, *A. sieversiana*, which they might have brought with them and are also being well used, in present Unani-tibb, (Wahid 1957). However, *Artemisia vulgaris* Linn. under the name 'Damnak', 'Davana' is reported to be used in Ayurvedic systems of medicine, Pandey, (1969,p.511) and Sarma, (1969,p.489). Laterwards, *A. absinthium*, *A. maritima*, were also adopted in Ayurveda as described by Sarma, (1969, p. 469,474). Not only this, later these species were found to be growing in the Himalayas mainly in the Kashmir Himalayas.

Use of *Artemisia* in traditional medicine in India: However, when the Britishers came to India, they started collecting and listing the medicinal & economic plants of India, Watt (1889-1896) and (1908) and as such, they established a museum of medicinal and economic plants at Howrah. Bal (1932), who became the curator of the museum catalogued all the medicinal plants, used in indigenous medicine. There are 522 items, and under which there are four *Artemisia* species. Whether, these were used in Unani or Ayurvedic systems of medicine is not clearly mentioned. The species, are stated, as under;

***A. absinthium* L. :** 'Afsanteen', is was known in India by different regional names, such as; 'Daman vishesh' 'Prantha parna', 'suparna', in Sanskrit; 'vilayati afsantenn', 'sarada' 'saparna' 'supreema' (Marathi); 'supeen', 'mastru' (Gujrati); 'mastru' (Bengali). Used mainly as an anthelmintic and stomach ailments, (Bal 1932 no.71). It is native to Europe and possibly, earlier, it was imported from Europe, therefore, called 'Vilayati afsanteen'. It is distributed in West Himalaya, common on slopes of Srinagar, Banihal, Tanmarg, etc., and later it was collected and brought from Kashmir for medicinal use.

***A. sieversiana* Willd. :** Known as 'afsanteen' desi' or 'Daun'. It is esteemed as a tonic, deobstruent, febrifugal, and anthelmintic and applied externally as a discutient and as an antiseptic. (Bal 1932 no.73). It is also distributed in Kashmir and Himachal Pradesh growing on marshy, sandy soil 2500-3500 m. Possibly, the plant was also collected from Kashmir, and it was sold in Bombay market under the name 'Desi afsanteen'. In other parts of the world it is distributed in Pakistan,



Artemisia absinthium. (Afsantheen). The medicinal use was first introduced by the Arabians about 800 A.D. in India.

W.Tibet, China west ward to S. Russia, Hazra *et al.*, (1995). Kaul & Bakshi (1984), report that it grows as a weed in cultivated fields above 3000 m.

***Artemisia maritima* L. :** It was known as 'kirmani' in Bombay by the Hakims, who prescribed the plant as an anthelmintic and deobstruent and as a stomach tonic, (Bal 1932 no.72). Earlier, the Arabians brought the plant with them or imported and later when it was known that it also grows in Kashmir it was collected from there. Now, botanically, it is *Seriphidium brevifolium* (Wall.) Y. Ling *et Y.R. Ling*.

***Artemisia vulgaris* L. :** 'Nagdauna', 'Matajari'. The plant is known in India by different names. But here we would only discuss those names, which phoneticacally produce the sound of 'dau'un' or 'dawn' like, 'nagdaun', 'nagdarni' and more precisely, in Marathi- 'davan', Gujrati- 'damro'. The plant was (is) used as tonic, anthelmintic, antispasmodic, and expectorant in diseases of children. Expressed juice is applied by the natives practioners to the head of young children for the prevention of convulsion. The Hindu Vaidya considered it to be valuable stomachic, and deobstruent.; its infusion was prescribed in, electuary and in cases of



Artemisia maritima (*Seriphidium brevifolium*) growing wild in Malari area in Dist. Chamoli. Utarakhand.

obstructed menses and hysteria. Externally, it is used in fomentation given in skin diseases and foul ulcers as an alterative, (Bal 1932 no.74). Botanically, it is now known as *A. dubia* Wall.ex Besser. It is to be further noted that *A. vulgaris* L. is not found in India.

Now a days, these species are seldom available in the crude drug market. Presently, the Unani and Ayurvedic medicines, are manufactured as proprietary medicines and these drugs are directly used in large scale by he manufacturers collected from the field by their suppliers or imported.

Ethnobotanical uses as an incense & as an offerings to local deities of *Artemisia* and *Serephidium* species from Kumaon Himalayas and N.E.India : Reporting the folk-uses of *Artemisia* species from Kumaon Hills, Shah & Joshi (1970) reported that *A. nilagarica* (Clarke) Pamp. syn. *A. vulgaris* Sensu Hook.f., which grows into a tall and bushy plant; *A. vestita* Wall ex DC., now a variety of *A. gmelinii* var. *vestita* is a hairy pubescent shrub with fern like leaves, and *A. parviflora* Buch. Ham ex Roxb. The lower leaves are wedged shaped. All these species are known as 'kunjia pati' or 'pati'. The aerial parts are very aromatic and used to worship the Goddess Nanada Devi (the local deity) and also used in death anniversaries for worshipping.

Later, the plant was collected by author from Joshimath and distilled the essential oil. The oil was assayed ,and the major aromatic constituents of the oil are; camphor (9.7%); 1-8cineole (6.5%); β -eudesmol (7.98); borneol (5.29%); artemisia alcohol (3,4%);camphene (2.59%); p-cymene (1.6%); terpene-4-ol (1.24%); α -pinene (1.2%); α -gurjunene (1.92%), Uniyal *et al.*, (1985). However, the plant at that time, was mis-



A. nilagarica used to worship goddess Nanda Devi in Kumaon.

identified later it was corrected as *Artemisia indica* Wall (*A. vulgaris* auct.non Linn), Shah (1992). The work on essential oil of *A. parviflora* and *A. vestita* from Kumaon Himalaya is not available in detail. However, from Kashmir Himalaya the essential oil assay of *A. vestita* Wall is available with other wild species growing at high altitudes, viz., *A. moorcroftiana* Wall., *A. lacinata* Willd., *A.*

salsolides Willd. and *A.persica*, Boiss., Kaul, (1997).

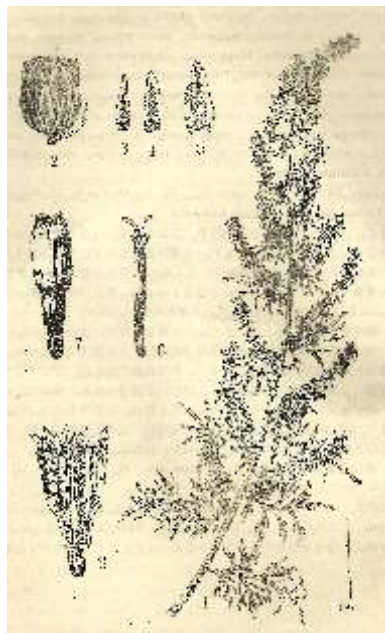
In North East India, the Mompas of Kameng District use the decoction of leaves of *A. nilagarica* (Clarke) Pamp. Syn. *A. vulgaris* Sensu Hook.f., in sores and call it 'Nilum'. The Nagas of North East Himalayas call the plant as 'Diti Bati' and keep the plant in front of their doors and below their pillows and believe that doing so, no evil spirits and ghosts enter the house, (Dam & Hajra, (1990) and Rao (1990), quoted by Shah (1996, p. 418.).

***A.sacrorum* Ledeb. now *A. gmelinii* Web.ex Stechm. :** Russian Wormwood. 'Ganga Tulsi', 'Kala-purcha'. It is known in Harsil and Gangotri in (Uttarkashi) region as 'GangaTulsi' and, in Niti, Mana, and Malari (Chamoli) region as 'Kala purcha' . The herb is 0.5-0.9 m. high found in dry alpine region from 2300-3000 m. In Harsil and Gangotri region the plant is used as *Ocimum sanctum*' the common, 'Tulsi' and used similarly in cough and cold and fever, therefore, called, 'Ganga tulsi'. In Malari and Niti the herb is used as incense and also offered to local deities. The plant was collected first by the author from Harsil (near Gangotri), in 1966, where it was found in abundance the leaf twig was being offered in Gangotri temple, and was known as 'Ganga Tulsi'. In author's second trip to Gangotri in 1979, the plant was not much seen. Possibly, the visitors must have discriminately collected the plant from the region to offer it in Gangotri temple. The plant was also collected by the author from Malari region to determine the artemisinin content and for the essential oil. Artemisinin was not detected. The yield of essential oil was 0.3 to 0.5% and the major constituents were; limonene (45.6%), borneol (11.1%), farnesol(9.2%),thujyl alcohol(9.0%),geranyl acetate (6.9%), α -pinene (6.5%), nerol(3.6%), thujone (2.8%), thujyl acetate (0.9%), cineole (0.2%), Shah, (1997) & (Annual Report CIMAP,1983-84).

Work on Indian *Artemisia* species in CIMAP : In the year 1981 work on *Artemisia annua* was carried out at CIMAP (Central Institute of Medicinal & Aromatic Plants, Lucknow. U.P.). It was also thought that if wild growing *Artemisia annua* is available within the country then it should be collected and assayed for artemisinin contents and the plant be collected as germ plasm for future breeding purpose, etc. As usual, the distribution of *Artemisia annua* in India was studied and came to know that it is mostly distributed in the Himalayas, Afghanistan, Pakistan, Nepal, Bhutan and in China. In India, it was recorded to be occurring in the Indo-Tibetan border area so the author took 4-5 survey trips to the Indo-Tibetan border areas, viz., Gangotri in district Uttarkashi, and Niti, Malari, Mana (Badrinath) in Chamoli district, in Uttarakhand, which are adjoining to Tibet. And, collected *Artemisia* species not only for detection of artemisinin contents but also for analysis of essential oils. About 5-6 species of *Artemisia* were collected from the higher region and accessioned in CIMAP herbarium. In second trip to Gangotri he collected *Artemisia* species, which was very much alike to *Artemisia sacrorum*. But, it was recorded as a new species, viz., *Artemisia filiformilobulata* Y.R.Ling et H.S.Puri *sp.nov.* (Sect. Abrotanum Bess.). S. Himalaya, Gangotri, 5000. Collected by N.C.Shah. Field Book No 266 A ; 22-9-1979.(Typus CIMAP). Similarly, from Niti border, in Chamoli, *Artemisia. astro-himalayana*, Y.R.Ling et H.S.Puri syn. *A. tenuifolia*, auct. non Adam. Ex DC. Y.R.Ling et H.S.Puri *sp. nov.* (Sect. Artemisia). S.Himalaya, Niti Chamoli,4000 m. collected by N.C.Shah et S.C.Singh, from Niti (CIMAP 1660), Typus CIMAP., (Ling & Puri 1985).

However, during authors trips to the border region from 1979-1986, he collected a good number of other *Artemisia* species such as; *A.gmelini* Web ex Stechm.(CIMAP 1434); *A. roxburghiana* Bess var. *grata* Hook.f.

(CIMAP 2831) Deoban ; (CIMAP 266) from Harshil; *A.pleocephala* Pamp (CIMAP 3620) from Jauljibi (Pithoragarh); *Artemisia filiformilobata* from Gangotri (CIMAP 266 A); *A. astro-himalayaca* from Niti (CIMAP 1660). But, *A. annua* could not be found and collected. But, if serious efforts are taken to scan the Indo-Tibetan Border region, and N.E. Border region then, likely it is collected.



Artemisia filiformilobulata, a new species collected by the author from Gangotri

However, a detailed information on santonin contents from *Artemisia* species in India is dealt by Chopra *op.cit.*, pp.65-72. Santonin was earlier used as an anthelmintic drug, now it is only used in veterinary medicine. Burger, (1986, p. 6) states that the Mediterranean peoples used the dried flowers heads of *A.maritima* to get rid off intestinal worms. The plant is native to South-Central Russia. The British chemists synthesized santonin but they could not separate effective doses from the toxic ones. The synthesized compound and the natural compound is used in veterinary medicine for round-worms.

The plant is well distributed in Malari area and the local people of Malari, the 'Bhotias' call it 'safed purcha' and use, only the immature leaves and the inflorescence of the plant as an incense. Therefore, The aerial part of the plants with immature leaves and mature leaves and inflorescence was collected in two seasons and distilled for essential oil, and the oil was assayed. It was revealed that the natives used only the immature leaves and inflorescence because the immature material contains high percentage of thujone and 1-8 cineole, i.e., (α -thujone (77.0%) and 1-8 cineole (3.5%) and the mature material contained α - thujone (60.29%) and 1-8 cineole (1.5%), and other aromatic constituents in detail, Shah & Thakur (1992). Further, it is presumed that the local people use the incense perhaps as a psychoactive property due to α -thujone, a monoterpeneketone, which is a mild intoxicating agent and thus they forget the fret & worries of life, and the severe cold conditions of the place and other domestic hardships, Shah (1996). Recently, thujone from *A.absinthium* and *Salvia officinalis* has been found as a drug for diabetes mellitus, Alhaj Badder, *et. al.*, (2011).

Economic *Artemisia* species cultivated in India: There are only a few numbers of economic *Artemisia* species, which have been recorded to be cultivated, in the past or are being cultivated presently or reported to be

found in the wild, or are only recorded in the herbaria, in India or abroad, are discussed below:

i. The species which were recorded to be cultivated in the past or are presently being cultivated are as follows:



Artemisia maritima (Seriphidium brevifolium) single plant, the santonin content from Malari was assayed to be 0.65 % and 0.68 %, (Chopra et. al 1958).

1. *Artemisia abrotanum* L. (Southern-wood, lad's love, southern wormwood): It is reported to be cultivated in Bombay, Graham Catalogue 1839 quoted by Karthikeyan, *et. al.*, (2009, p.192). It is certain that the plant do not exist now, anywhere under cultivation or wild. However, Hazra *et. al.*, (1995), has not enumerated it.

Botany: It is a small bushy shrub, with small, feathery, narrow, grey-green leaves. The flowers are small and yellow. It can easily be propagated by cuttings, or by division of the roots.

Distribution: It is an European plant found in the Mediterranean countries southwards. It is mainly distributed in E. Antolia, Armenia Tunicia, The native area of this species has remained uncertain but it is wild in E. Antolia. The plant is described from Syria and Turkey, (E.Davis in Flora of Turkey vol.5.p.314). Possibly, in the past, it was brought to India by some European during British period, due to its various uses, as discussed below:

Uses: (Aromatic use). The plant is known from ancient times, and it has a strong camphor-like pleasing aroma and was historically used as an air freshener or strewing herb. Its infusion used in gastric disorders, and used externally as bath-water, aromatic tonic and its poultice in frost bite. The pungent, scented leaves and flowers are used in herbal teas. It is also used as a Kitchen herb. Young shoots were used to flavor pastries and puddings. In Italy, it is used as a culinary herb.

A yellow dye is extracted from the branches of the plant for colouring wool. Its dried leaves are used to keep moths away from wardrobes. It was customary to lay sprays of the herb amongst clothes, or hang them in closets, hence called, "garderobe" or clothes-preserver. It is stated that whenever, the Judges visited the prisoners they carried with them the posies (cloth bags) of 'southernwood' and the rue (*Ruta graveolens*) 'Harmal' to protect themselves from the prisoners' contagious diseases. It was also used by some church-goers, who relied on the herb's sharp scent to keep them awake (not to sleep) during the long sermons. It is reported that it is cultivated in Germany, (Stary & Jirasek,1973,p.,78).

2. *Artemisia princeps* Pamp. : 'Japanese Mugwort. It is known as 'yomogi' in Japan, and in China it is known as 'huang hua ai'. Karthikeyan *et al* (quoted Almeida J.Econ.Taxon Bot. addl.ser. 8(1): 236,1990) (2009) and listed the plant as cultivated.

Distribution: It is distributed in the South-Asian countries.

Botany: It is a perennial, very vigorous plant that grows to 1.2 meters. It bears small, buff colored small flowers, which are hermaphroditic, and



Artemisia abrotanum (Southern wormwood) once, grown in India during British period.

pollinated by wind. The leaves are feather shaped, scalloped and light green, with white dense fuzz on the underside. This species spreads rapidly by means of underground stolons and can become invasive.

Parts used: Aerial parts and leaves.

Uses: The plant is mostly used in Japan, China, Korea, etc. The leaves are sometimes blanched and added to soups or rice. Leaves and young seedlings can be eaten raw or cooked. They can also be used in salads and soups after boiling to remove the bitterness. The young leaves can be lightly boiled before being pounded and added to glutinous rice dumplings known as 'mochi' to which they give a pleasant colour, aroma and flavour. It is used in Moxibustion, a traditional medical practice, in which the plant is burnt and placed over the wound or injured part for early healings.

ii. There are species which are found in the country in the Himalayas and are being cultivated elsewhere but not with in the country.

3. *Artemisia dracunculus* L. Dragon Mugwort, Estragon, Tarragon.

Distribution: In India it is distributed in the North-West and Western Himalayas at 14000-16000 ft in Kashmir, Lahul, Nubra, Shyok and Zanskar in Ladakh, Chopra *et al* (1956 and 1958) and Stewart (1972).



Artemisia princeps (Japanese Mugwort) another plant, which was once grown in India during British period.

It is mainly distributed in the central, southern and eastern region of Russia, Siberia, Mongolia, Tibet, in Northern China and also in North America.

Botany: It is a 90 cm high perennial herb or semi shrub with smooth, glossy, dark green, long narrow leaves

shooting from opposite sides of wiry stalks.

Parts used: Soft aerial parts at the flowering stage and leaves, are used

Medicinal uses: It is taken in form of infusion to stimulate the appetite in treatment of gastric and intestinal catarrh and intestinal parasitic infestations and also as a mild diuretic. It is a bitter tonic used in indigestion and in gastric troubles, (Stary & Jirasek, 1973, p.78,80,82).

Other Uses: It is generally used in French, European and American cuisine. It is mainly used in making Tarragon vinegar and to flavour mustards, soups stews, egg, chicken, and other meats, salad, lobsters, pickles, mushrooms, and fish dishes. It is also used in garnishing salads.

Cultivation: It is cultivated in Southern Europe mainly in France and Spain and former is the main market for its supply. It is also cultivated in Morocco.

Principal active constituents: Essential oil 0.25-0.3 % with aniseed like sweet odour and methyl chavicol 60-70 %, are the main constituents, Chopra *et al.*, (1956). Asolkar *et al* (1992) reviews the main constituents of essential oil, and the herbs as flavons, including rutin, artemitin hyperoside, etc.

Trade: It is the costliest culinary herb. The French variety is sold in higher rates than the Russian variety. The Netherlands and Iran also produces Tarragon. Though, Morocco and eastern European countries also grow but a cheaper quality Tarragon. Though, Germany also produces top grade Tarragon but in lesser quantity.

It is required that systematic survey of *Artemisia dracunculoides* (Tarragon) be conducted in the Indian Himalayas, where these have been reported to occur. Its essential oil be chemically examined and assessed and if found suitable then brought under trade like 'Davana' (see below) after proper evaluation.

iii. There are only two species of Artemisia which are well cultivated in India, viz., *A. pallens* and *A. annua* and these are as follows:

4. *Artemisia pallens* Wall. ex DC. 'Davana'. It is grown in gardens and cultivated in fields in Andhra Pradesh, Tamil Nadu and in Karnataka

states, where there are no heavy rains. In Karnataka and Tamil Nadu it is stated to be cultivated in large scale for production of 'Davana oil' which is used in high class perfumery and is exported.

Botany: *Artemisia pallens*, was first botanically recorded by Hooker (1881) but he cited it as doubtful species. Further, it has never been seen in wild condition. Hazra *et al* (1995) did not mention this plant? However, Karthikeyan, *et al.*, (2009) have also mentioned it with a note as a doubtful species.

Actually, it is an introduced plant in India, the origin is yet to be known. At the time, when it was introduced possibly by the Britishers due to its pleasant aroma, *A. dubia* Wall. ex Besser. earlier known as *A. vulgaris* auct. non Linn. (referred earlier as *A. vulgaris*, L.) growing wild, and

was used in Ayurvedic and folk medicine, and was known as; 'dau'un' or 'dawn' like, 'nagdaun', 'nag damni' and more precisely, in Marathi- 'davan', Gujrati- 'damro'. 'Dauna'. Phonetically, 'Dauna' could be pronounced by the Britishers as 'Dauvana' and they began to call the newly introduced plant, *A. pallens* as 'Davana' phonetically alike 'Dauna'. Hence, the new plant was known as 'davauna', or 'davana'.

Cultivation: According to Badhwar *et al.*, (1964) and Husain *et al.*, (1988) in cultivation the plant is 15-30 cm high. However, two distinct types have been identified, **i.** With short stature having basal leaves entire and early flowering, and **ii.** Tall ca. 60 cm. with leaves highly dissected and late flowering, (Asolkar *et al.*, 1992). It is a short term winter crop extending from Nov. to Feb. under south Indian conditions.

Uses : From India, the distilled essential oil is exported to Western Europe and North America, to be mainly used, in sausages and various prepared pork products and in high grade perfumery and scents. The demand is generally stable about 2 tons of essential oil is exported, (Anonymous 1986, p.22) and Kak & Kaul (1997, p.278) reported its production of 4 tons.

The local people use the 'Davana' blossoms to be offered to Shiva, and decorate His altar throughout the day. According to Asolkar *et al* (1992) 'Davana' as sachet powder for preserving delicate fabrics against moths are in the market.

Chemical Composition: 'Davana' oil consist of davanones- (55.0%), nerol- (10.0%), Geraniol --(5.0%), hydroxyl davanone-(3.0%), dihydroxyrosefurans- (2.5%), furano-norditerpenoid- (2.0%), hydroxyl nerolidol- (2.0%), davana ethers- (1.5%), artemone (1.5%), davana furans - (1.0%), davana esters- (1.0%), hydroxydihydrorosefuran-(0.5%), and number of other aroma chemicals in minute concentration, Thakur & Misra 1989 quoted by Kak & Kaul (1997, p.276.).

***Artemisia annua* L.** Annual wormwood, Sweet wormwood, Sweet annie and 'Ginghaosu' or "Qing Hao Su" in China. Hooker (1881), Bamber (1916), Stewart, (1972) show the distribution of the plant from Peshawar to Waziristan and Panjab (Pakistan) and Nguyen Xuan Dung, (1996) states, Siberia, Eastern Europe, Tibet, South China, North Vietnam, and North America. It is stated to be Asiatic and Eastern European in origin, widely distributed throughout the temperate region.



Artemisia pallens (Davana) presently grown in South India, and essential oil more than 4 tons per annum is exported mostly to USA to be used in high class perfumery and also for food preservation.

However, it has yet not been reported from the Indian territory and herbarium survey by the author conducted in 1981 has confirmed it. The author still believes that it may be available between Indo-Tibetan border, if a serious survey, is conducted.

It is an erect aromatic annual under shrub, stem angular. In wild condition it is a short plant but rises to 1-1.5 m. under cultivation. Used as an aromatic wreath in USA and in Europe its essential oil used for flavouring beverages.

***Artemisia annua* in China:** It

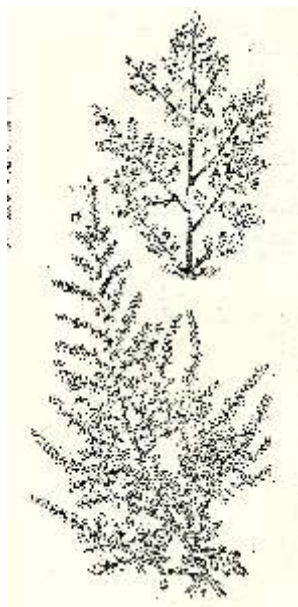


Artemisia dracunculoides L. (Tarragon). Found wild in the Western Himalayas but never been cultivated. It is a French, American cuisine presently cultivated in Morocco and Germany.

is known as "Qing Hao Su" and the Chinese knew that it contains, a compound with C₁₅H₂₂O₅, (artemisinin), which treats Malaria, Ling (1986). The plant has long been grown in China traditionally as a medicinal article under the name, 'Ginghaosu'. It yields an important compound known as artemisinin, a sesquiterpene lactone endoperoxide discovered by Klayman *et al.*, in (1984). Artemisinin content of 0.06% have been reported from samples of *A. annua* collected in the United States (Klayman *et al.*, 1984), which were very low for commercial exploitation. Furthermore, analysis of artemisinin is difficult because the compound is unstable, concentration in the plant low, the intact molecule stains poorly, and other compounds in the crude plant extracts interfere in its detection. Yields of extracted artemisinin from the above-ground portions of the plant have ranged from 0.01% to 0.5% (w/w) in the People's Republic of China.

Artemisinin derivatives, like; artemether and artesunate, have been studied for their efficacy as antimalarial agents. At present *A. annua* is being cultivated in most of the European countries. The work on *Artemisia annua* as an anti-malarial drug in China and the work of Klayman *et al.*, (1984) in USA had attracted the attention of the plant laboratories of the world, working in developing new medicines.

Artemisia annua in Vietnam: It is known as ' thanh hao' 'than cao vang' in Vietnam. In Indo-China it is considered, a good diuretic and prescribed in jaundice and skin diseases and as an anti-malarial, as an anti-pyretic and, in chronic dysentery. Topically applied as bactericide for scabies, in abscess and diseases of eye. It is also digestive and aperients recommended to pregnant women, and after child birth used as an appetizer, Nguyen Xuan Dung, et al, (1996, p.)

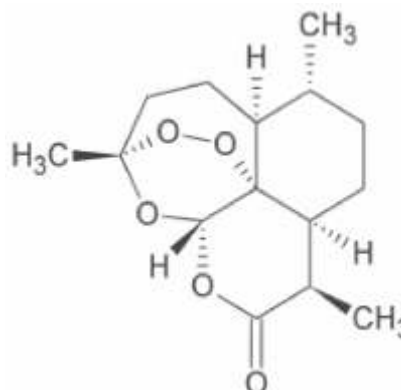


Artemisia annua (Sweet Annie) discovered from china as an anti-malarial drug. Flowering & fruiting branches line drawings from China.

which is essential for anti-malarial activity.

In view of the number of chloroquin-resistant strains of *Plasmodium falciparum* which are emerging in Asia, south and Central America and Africa, and the need for new anti-malarials was accorded on top priority by WHO. Attention of CIMAP in this area was also drawn no sooner the

publication of the antimalarial activity of *Artemisia annua* was reported in the Chinese literature. Through the courtesy of Dr. Nityanand (ex-director CDRI), 3 gms. of *Artemisia annua* seed were procured from the Royal Botanical Gardens, Kew and cultivated in CIMAP Bonera Farm (Dist.Phulwama) in Kashmir Valley. Some plants were raised for seeds and a part of crop processed chemically to obtain antimalarial drug. In this effort 0.16 yield of artemisinin, the antimalarial chemical constituents of *Artemisia annua*, was obtained from the aerial part of the plant.



Artemisinin is a sesquiterpene lactone containing an unusual peroxide bridge. This peroxide is believed to be responsible for the drug's action.



Artemisia annua (Sweet Annie). A single vegetative branch.

small quantities Artemisinin for experimental work for 1985 but we propose to produce bulk quantity of artemisinin in 1986-87. The chemical processing for artemisinin has been established. The compound has cured several thousand malarial patients in China. It is effective against both chloroquine-sensitive and chloroquine-resistant strains of *Plasmodium falciparum*. In addition, it is very effective against cerebral malaria. It has been considered as a very potent antimalarial drug especially in areas, where chloroquine resistant strains of *Plasmodium falciparum* is found", Shah, (2012).

It has been found that *A. annua* is relatively easy to grow and that it has a very high biomass yields (35t/ha) could be obtained, in appropriate

The success of cultivation in experimental fields in Kashmir valley as well as in Lucknow offers bright prospects for its introduction as an important crop of anti-malarial drug. The yield of Artemisinin, in *Artemisia annua* cultivated in Kashmir valley is of the order 0.1 % the efforts are being made to grow

larger quantities of *Artemisia annua* in Kashmir valley. In an effort to have high yielding strains of *Artemisia annua* seeds are being procured from Iran, Afghanistan and Turkey. Recently, we have procured seeds from Western Europe and from USA and France, through the courtesy of Prof Klayman, Walter Reed Army Institute of Research. It is hoped that in the forthcoming season we will be able to cultivate *Artemisia annua* in a couple of hectare of land. We have

spacing. Not only this, Chen, *et. al.*, (1987) have also reported the Allelopathic effect of artemisinin.

Essential Oils: Essential oils of *A. annua* extracted *via* steam distillation is comprised of many constituents with the major compounds such as; alpha-pinene (0.032%), camphene (0.047%), beta-pinene (0.882%), myrcene (3.8%), 1,8-cineole (5.5%), artemisia ketone (66.7%), linalool (3.4%), camphor (0.6%), borneol (0.2%), and beta-caryophyllene (1.2%), (CIMAP Annual Report 1989-90).

Chemical constituents of Essential oil from Vietnam : However, from Vietnam more than 15 chemical constituents have been reported with an yield 0.4%-0.6% by Nguyen Xuan Dung, *et. al.*, (1996, p.657) quoting Nguyen Xuan Dung, *et al* (1991). The chemical constituents are; α -



Artemisia annua (Sweet Annie). A single fruiting branch

pinene (0.74%), camphene (1.78%), sabinene (1.10%), beta-pinene (0.44%), beta-myrcene (4.8%), 1,8-cineole (15.44%), Artemisia ketone (4.42%), linalool (0.46%), limonene oxide (2.93%), camphor (23.75%), 2-methylene-5-isopropenyl cyclohexinol (2.91%), artemisia alcohol (2.67%), terpinen-4-ol (2.27%), geranyl acetate (1.01%), alpha-cubene (0.97%) (5.59%), beta-caryophyllene (6.29%), beta-farnesene (9.59%), delta-cadinene (0.63%) and beta-cubene (5.59%).



Artemisia annua (Sweet Annie) plant growing in field at CIMAP. The plant is annual but in cultivation in Lucknow condition becomes perennial and yields good quantity of biomass.

***Artemisia annua* researches in India:** Certain improved technologies for the processing and production of artemisinin and essential oil; single pot conversion of artemisinin to artesunic acid; single pot conversion of artemisinin to artemether and the process of isolating artemisinin from *Artemisia annua* have been developed and patented by CIMAP, in India (Annual Report CIMAP 2003-2004 pp.90-91). The plant has been well established and naturalized for cultivation in India. The progress is continued in collaboration with CDRI, Lucknow.

Prospects of *Artemisia annua* and other *Artemisia* species in India :

No doubt, in past thirty years, the crop of *Artemisia annua* has been well acclimatized and established in India by CIMAP, Lucknow. Not only this, agro-technology has also been well established for its future agriculture, in different parts of the country. Not only this, improved technologies for the processing and production of artemisinin and its other semi synthetic products and essential oil, has also been well established and available. About 15 yrs ago IPCA Laboratories, Ltd. had taken all the patented technologies from CIMAP to start cultivation through out India and produce artemisinin, in a big way likely they couldnot do well. As we know artemisinin and its other products, are well in demand within the country and abroad. China being a big competitors in this field, supplies drugs at lower cost.

There is possibility in India, to cultivate other well established economic species like; *Artemisia abrotanum* L, *Artemisia princeps* Pamp. and *Artemisia dracunculus* L. which were earlier cultivated in the past and are being cultivated in other parts of the world for economic gains.

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