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## Davana a potential under exploited aromatic crop of south India: A review

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### Abstract

Davana is an annual aromatic herb whose flower heads are used as economic part. Because of its fruity odour it is used in bouquets, flower garlands and pharmaceutical industries. It smells differently on different persons, because of this peculiar character it is widely used in high grade perfumes. India occupies monopoly in production and export of davana essential oil. It is a hardy crop widely grown in South India as a winter crop during February-March and it is commercially propagated by seeds. Wet method of sowing gives better and good quality seedlings. The growth was very slow in nursery so urea spray at 0.1% after 3 weeks in nursery will improve the growth of seedling. FYM at 6t/ha and NPK at 120:40:40kg /ha is recommended for good yield. GA<sub>3</sub> @ 200ppm after 5 weeks of transplanting will give better yield and quality of oil. Damping-off is the only disease affecting the crop during nursery and at field. The crop is harvested during 50% flowering stage because the oil content is maximum in flower heads.

**Keywords:** Davana, *Artemisia pallens*, monopoly, high grade perfumes, flowering stage

### Introduction

Davana (*Artemisia pallens* Wall.) (2n=16) is an important annual aromatic herb, belonging to the family Asteraceae much prized in India for its delicate fragrance. It is a common aromatic plant of south India grown for its leaves and flowers and prized for its fruity fragrance. It forms an important component in garlands and bouquets, where sprigs of davana lend an element of freshness and a rich fruity odour (Balakubahan *et al.*, 2011) [4]. The sprigs of davana are widely used in floral composition by women folk for decorating their hair (Gulathi, 1980) [8]. Cis-davanone in the oil is responsible for its characteristic odour. The esters are the major constituents responsible for the smell of davana. The fruity odour is due to the presence of davanafurans. There are more than 26 types of chemicals in davana oil and major ones are Davanone (50%) and Nerol (10%).

### Origin and distribution

The plant grows wild in the temperate Himalayas. It is common in the Kashmir Valley, the Simla and Nainital Hills. It is being commercially cultivated in Karnataka, Maharashtra, Kerala, Tamil Nadu and Andhra Pradesh in an area of about 1000 ha. The genus *Artemisia* comprises of about 280 species, mostly found in temperate regions of the world (Rao *et al.*, 1978) [24]. In India the genus *Artemisia* is represented by over 30 species restricted to Himalayan belt, with a few species growing in the tropical and the subtropical zones (Bakshi and Kaul, 1984) [3]. Attempts to raise this crop have been made in North Indian agro climatic conditions with limited success (Gulathi, 1980) [8]. Karnataka stands first in area and production of davana in which the major area is under Bangalore.

### Uses

Davana is commercially grown for its essential oil mainly used for perfumery, food flavouring and medicine. The leaves and flowers contain an essential oil valued for its exquisite and delicate aroma and is used in high grade perfumes and cosmetics (Ramachandriah *et al.*, 1984). When applied on the skin, Davana is said to smell differently on different persons. This peculiar property is highly valued in high class perfumery to create fragrances with truly individual notes.

Davana plant is accredited with antihelmintic, antipyretic and tonic properties and also considered as a good fodder. The oil possesses antispasmodic, antibacterial, antifungal and stimulant properties (Suresh, *et al.*, 2011) [27].

Davana possess anti-diabetic properties and was used in traditional medicine against diabetic because it is hypoglycaemic, increases peripheral glucose utilization or inhibits glucose reabsorption (Manisha *et al.*, 2007). The essential oil of Davana which is a brown, viscous liquid with a rich, fruity odour has acquired a considerable reputation in the international trade, particularly in USA and Japan where it is being used for flavouring cakes, pastries, tobacco and beverages.

### Chemical composition

The oil of Davana contains hydrocarbons (20%), esters (65%) and oxygenated compounds (15%). The esters are the major constituents responsible for the characteristic smell of Davana. Saponification of the oil gives 10% cinnamic acid, while the alcohol part gives viscous oil with a high boiling point. It is reported that a new sesquiterpene ketone called cis-davanone in the oil is responsible for its characteristic odour. The other constituents isolated from the oil include a sesquiterpene ketone named 'artemone', novel sesquiterpenoids named. 'davanafurans' and another ketone named 'isodavanone'. Cis-davanone (45.8%), bicyclogermacrene (9.6%), linalool (2.5%), caryophyllene oxide (2.2%) and phytol (2.1%) were found to be the main constituents of the davana oil. The main constituents of the fraction were analyzed as cis-davanone (72.2%), davana ether 2° (5.2%) and (Z)-ethyl cinnamate (5.2%) (Bail *et al.* 2008) [2].

*Artemisia herba-alba* oils were characterized by the predominance of monoterpene derivatives (68.2-99.5%) and the major volatile constituent was  $\alpha$ -thujone (18.2-45.5%). Qualitative and quantitative differences between the four essential oils have been noted for some compounds. The main compounds of leaves essential oil were  $\alpha$ -Thujone (45.5%),  $\beta$ -Thujone (11.4%), trans-sabinyl acetate (10.1%), 1,8-Cineole (7.4%) and camphor (6.8%).  $\alpha$ -Thujone (27.5%) was also the main compound in the essential oil of leaves/stems, followed by camphor (22.9%), 1,8-cineole (8.3%),  $\beta$ -thujone (8.2%) and camphene (5.6%). The essential oil of stems was dominated by  $\alpha$ -Thujone (28%) followed by  $\beta$ -Thujone (11.4%) and chrysantenone (11%). In the essential oil of roots,  $\alpha$ -thujone was less represented (18.2%), followed by camphor (14.6%) and curcumen-15-al (14.3%). It is important to mention that curcumen-15-al has been reported for the first time in *Artemisia herba-alba* oil (Sana *et al.*, 2016) [25].

### Description of the Plant

Davana is an aromatic, erect herb, about 60 cm tall, with much divided leaves and small yellow flowers. The stem and leaves are covered with grayish-white tomentum. The leaves are alternate, petiolate and lobed. The inflorescence is capitulate with flowers which are peduncle to sessile, axillary or forming lax racemes, simple, heterogamous having bisexual disc florets in the centre and a few pistillate ray florets on the periphery. The outer florets are glabrous except for a few cottony hairs, tubular, generally 3-lobed. The stigma is generally 2-lobed and rarely 3-lobed. The inner florets are glabrous except for a few cottony hairs, tubular, 5-lobed and bisexual: the stamens are 5 in number with free, epipetalous filaments and a ditheous inflorescence: it has syngeneous anthers which are connective, prolonged, tapering style and bifid (Kulkarni, 2001) [14].

**Soil:** The crop is found growing on various types of soils from sandy loam to medium black. However, a fertile, well-drained, sandy loam soil which is rich in organic matter is ideal. Davana is suitable for nutritionally eroded soil (Aishwath and Rattan, 2016) [1].

**Climate:** Season is an important aspect to be considered when Davana is grown for extracting essential oil. It is cultivated in a limited area in the south India because of its preferred climatic conditions (Husain *et al.*, 1998) [10]. The oil content in the plants was observed to be maximum, when the crop was grown during the winter season compared to the other seasons. Thus, when the crop is grown for the production of oil, it should be planted during the first week of November. A few light showers with moderate winter conditions and no frost is conducive to the good growth of the plant.

**Nursery raising:** Davana is propagated by seeds. As the seeds lose viability rapidly, only the seeds from the previous season's crop should only be used for sowing. Nursery is raised during September to October for essential oil extraction (Farooqi *et al.*, 1997). About 1.5 kg of seed is required to produce enough seedlings to transplant into an area of one hectare. Usually, nursery-beds 2 m long and 1 m wide are preferred. The surface of the beds should be clod-free. It is then incorporated with finely prepared FYM at the rate of 10 kg per bed. The seeds may be sown either dry or after wetting them along with sand for about 48 hours. Davana seeds upgraded with petroleum ether improved the seed quality parameters *viz.*, germination percentage (71%), and vigour index (170.0) (Jayanthi & Vijayakumar, 2016) [12].





**Fig 1:** Davana at nursery stage

While sowing the dry seeds, they are mixed with sand in the ratio of 1:10 and broadcasted homogenously all over the bed. A thin layer of sand is then spread uniformly to cover the seeds and the beds are hand watered twice a day. To prevent the ants from carrying away the seeds, an application of 10 kg/ha of Heptachlor to the soil about 10 days prior to sowing has been helpful. Using this method, the germination of seeds is observed in about 4-5 days.

In areas where there are rains at the time of nursery raising, the seedlings may be grown on raised nursery-beds which will also help in reducing the incidence of damping-off disease. As there is a very slow growth of seedlings initially, foliar sprays of urea (0.1%) at weekly intervals, 3 weeks after sowing, may be given to boost their growth.

### Transplanting

The seedlings will be ready for transplanting in about 6-8 weeks from the date of sowing. Seedlings of 35 days old age exhibited best growth in terms of vigour index (168), survival percentage, plant height (45.1cm), number of branches per plant (18), number of flower heads per plant (87), seed yield per plant (5.3g), 1000 seed weight and seed germination (64) (Dutt and Tata, 2017) [19]. At this stage, the seedlings should be about 10 cm tall. The seedlings transplanted on 15<sup>th</sup> November recorded the maximum number of branches/plant, seed yield/plant, seed yield/plot, moreover the seeds obtained from 15<sup>th</sup> November sowing resulted good seed germination and vigour index (Jayanthi *et al.*, 2013) [13]. The essential oil yield was maximum in early transplanting (20<sup>th</sup> October) and closer intra-row spacing (15 cm) (Janardhanrao, 1989) [11]. Before transplanting, the field is thoroughly prepared by bringing the land to a fine tilth with repeated ploughings. It is then laid out into plots of convenient size by laying out bunds and channels. The size of the plot depends on the conditions prevailing locally. However, generally, plots of 3-4 m x 1.5-2.5 m size are preferred as it facilitates irrigation, weeding and other intercultural operations.

After the preparation of the plots, the soil is incorporated with 6 t/ha of well decomposed FYM or compost. The plots are irrigated a day prior to transplanting. The seedlings are then transplanted at a spacing of 15 cm between rows and 7.5 cm between plants. Trials have shown that transplanting davana plants at closer spacing resulted in higher herbage-yield, subsequently, higher oil-yield compared to wider spacing, which results in larger plants but lower herbage and oil-yield per unit area. Wider spacing (45 cm X 15 cm) increased all growth and yield components except plant height and (Leaf Area Index) LAI which were found significantly higher with

closer spacing (15 cm X 10 cm) (Narayanappa *et al.*, 2004) [16, 17]. The close spacing of 15 cm x 10 cm recorded higher fresh herbage (14.30 t/ha), air dried herbage (6.73 t/ha), essential oil (15.07kg/ha) and davanone yield (4.61kg/ha) (Narayanappa *et al.*, 2003) [18].

Spacing of 15 cm X 10 cm recorded higher gross returns, net returns and B: C ratio in main and ratoon crops of davana (Narayanappa *et al.*, 2004) [16, 17].

### Micropropagation

In davana highest callogenic response (100%) was shown by shoot tip explants with 2 mg/L 2, 4-dichlorophenoxyacetic acid. The highest number of shoots ( $14.25 \pm 1.65$ ) and highest shoot length ( $4.25 \pm 0.47$  cm) were observed on MS medium with 3 mg/L kinetin. After 40 days, shoots grown in vitro were transferred to rooting media. The highest number of roots ( $12 \pm 0.08$ ) and root length ( $8.15 \pm 1.13$  cm) were recorded on MS medium with 3 mg/L indole-3-butyric acid. The regenerated plantlets after 30 days were hardened in plastic cups containing sterile garden soil, farmyard soil and sand (2:1:1) and were transferred to a greenhouse (Nathar and Yattoo).

### Manures and fertilizers

Davana responds well to the application of manures and fertilizers. Well-decomposed FYM at the rate of 6 t/ha is incorporated into the soil at the time of land preparation. Subsequently, a fertilizer dose of 40 kg P and 40 kg K/ha is given at the time of transplanting. N is given in split doses at rate of 120kg/ha first dose at 10 days after transplanting and other 2 doses at 15 days thereafter. The application of 100kg N and 26 kg P resulted its the maximum uptake of NPK by davana as well as in the increased N and P contents and biomass yields (Rajeshwara *et al.* 1989) [21]. The highest gross income and net profit as well as net profit due to N application and net returns per rupee invested were obtained by supplying the crop with 80 kg N/ha (Rajeshwara *et al.*, 1999) [22]. Application of 50%RD NPK + Vermicompost  $2.5 \text{ t ha}^{-1}$  + *Azospirillum*  $2 \text{ kg ha}^{-1}$  + *Phosphate solubilising bacteria*  $2 \text{ kg ha}^{-1}$  recorded maximum essential oil yield per hectare (15.04 kg), which was on par with 75%RDF + *Azospirillum*  $2 \text{ kg ha}^{-1}$  (15.03 kg) (Shetty *et al.* 2014).

### Irrigation

After transplanting, the plots are immediately provided with light irrigation. Later, irrigation is provided daily till the seedlings are well established (10-12 days) and, subsequently, once in 3-4 days depending on the weather conditions.

Irrigation given at 15 mm CPE gave significantly higher growth components viz., plant height, total chlorophyll content, leaf area per plant, LAI and total dry matter accumulation and yield components viz., fresh weight per plant, fresh weight of flower head per plant, 100 flower head weight and flower head to biomass ratio (Narayanappa *et al.*, 2004) [16, 17]. Irrigation given at 15 mm CPE gave significantly higher fresh herbage 13.54t/ha, air dried herbage (6-15t/ha) essential oil (13.67 kg/ha) and davanone yield (4.59 kg/ha) (Narayanappa *et al.*, 2003) [18]. Irrigation at 15mm CPE recorded higher gross returns, net returns and B: C ratio in main and ratoon crops of davana (Narayanappa *et al.*, 2004) [16, 17].

### Interculture

The field is kept weed-free by regular weeding as and when required. In all, about 2-3 hand-weedings during the early period of growth will help to keep the weeds down.

### Growth regulator application

Growth regulators have been used to boost the growth and yield in many crops. In Davana also, an application of GA at 200 ppm after five weeks of transplanting has been found to increase the herb and essential oil-yield per unit area (Bhagya *et al.*, 2015) [5].

### Insect Pests

No serious attack of insect pests has been reported in Davana. However, some insect pests like leaf-eating caterpillars, aphids and termites have been observed to after the crop.

The application of Aldrex to the plots will control the attack of termites, while the spraying of any systemic insecticide like 0.05% of Monocrotophos or 0.2% of Dimethoate will control the incidence of aphids and the spraying of contact insecticides like 0.2% Metacid will control leaf-eating caterpillars. Root-knot nematodes such as *Meloidogyne incognita* and *M. javanica* attacking to Davana were reported which have been a new constraint to davana cultivation.

### Diseases - Damping-off

This disease is caused by fungus belonging to the *Rhizoctinia* spp. It is usually severe at the nursery stage, particularly when there is high humidity and cloudy weather conditions, resulting in the heavy mortality of seedlings. Controlling the irrigation will reduce the incidence of the disease. Treating the seeds with Emisan @ 0.2% or Ridona MZ at 0.1% before sowing and then drenching the seed-beds with the above chemicals a week after germination controls the disease. *R. solanacearum* in davana constitutes the first record of bacterial wilt on davana in India, the isolates belongs to race-1, biovar-3 (Kumar *et al.* 2018).

### Harvesting

The crop starts flowering after 110-115 days of sowing, which will be around the 2<sup>nd</sup> or 3<sup>rd</sup> week of February. In order to obtain the maximum essential oil-yield, the plants should be harvested when about 50% of them have come to the flowering stage. Full blooming stage is ideal for harvesting and it was also confirmed with the normal practice of farmers harvesting the crop (Channayya *et al.*, 2020) [6]. This is usually at the end of February or in the 1<sup>st</sup> week of March, about 120-125 days after sowing. Harvesting is done by cutting the plants from the base. Although there are reports

about the possibility of obtaining a ratoon crop in Davana, it is not practical as the main crop is harvested only during the month The of March and the ratoon starts sprouting by the end of March or the beginning of April which, due to the high temperatures prevailing during these period, results in poor growth of the plants and mutilated flower-buds which may even fail to open. The crops, thus obtained, become uneconomical as the flower-heads are the major contributors of oil.



Fig 2: Davana at flowering stage

### Distillation

The harvested material, before distillation, is dried under the shade for 2 days. It is better to distill this immediately rather than to store it. The dried material is steam-distilled to obtain good quality oil. However, for the estimation of essential oil under laboratory conditions, particularly of a small sample, the shade-dried material is hydro-distilled.

In the case of hydro-distillation, the material is placed in a glass still and water is added to it, so that around three-fourths of the material is immersed in water and it is then heated. During boiling, the water vapours along with the vaporized oil moves into the condenser, gets condensed and collects in a graduated receive. Based on the amount of oil collected, the oil content of the material can be determined.

However, for commercial purposes, steam distillation should be used. The distillation equipment consists of: (i) A Boiler, which produces the steam; (ii) A Distillation Still in which the material is filled and steam is passed through; (iii) A Condenser, wherein the vaporized oil gets condensed into a liquid form and (iv) A Receiver, to collect the oil.

The boiler and the distillation still are made of steel. The boiler is connected to the distillation still by a steel pipe through which the steam passes. A perforated grid (plate) is placed at the bottom of the still on which the plant material is kept. The distillation still is connected to the condenser through a pipe. The condenser consists of many metallic pipes mounted inside a jacket. It is provided with an inlet and an outlet. Water is passed through the gap between the pipes in order to cool the steam and essential oil vapours into liquid form, which then gets collected in the steel receiver. The oil, being lighter than water and insoluble, floats on the surface of the water.

For distillation, the air-dried herbage is chopped into smaller pieces and then charged into the still. While filling, the material should be tightly packed inside the still, as otherwise steam channels may be formed during distillation resulting in poor yields. About 5-6 hours are required to complete the charge.

After decantation of the top, clear layer of oil, the bottom

layer which consists of small quantities of water and oil has to be clarified. To separate the oil, a saturated solution of sodium chloride is added to this mixture so that a separated layer of water and oil is formed. The lower water-layer is drained off with the help of a separating funnel and the upper layer of oil is collected.

### Yield and Oil Content

The yield of fresh herbage, including flower-heads, is around 12-13 t/ha. Though, under laboratory conditions, the oil content in the whole plant after drying it in the shade for 2 days is 0.29%. An average recovery of around 0.2% under large-scale distillation, yielding 12-13 kg/ha of oil may be considered satisfactory.

When oil is extracted from the whole plant, the flower-heads contribute the major portion of the oil. The contribution of the leaves and stems towards the percentage of oil content in a whole plant is very little. The percentage of oil content in different plant parts, worked out under laboratory conditions on W/W basis, is as follows

Plant part	Percentage of oil content (2 days, air-dried basis)
Flower-heads	0.53
Herbage (leaves + stem)	0.14
Whole plant	0.29

### Marketers and sellers of davana oil

1. BRM Marketing, Plot No-23 Tps Complex, Mulbagal, In front of Court, Bengaluru, Karnataka, 563131, India.
2. Global merchants, R, 322, Midc Industrial estate, Ttc Rabale, Navi Mumbai, 400701, Maharashtra, India.

3. Sivaroma Naturals (P) Ltd, B-99, Industrial Area Phase-Ii Noida (Up)-201305, India.
4. Surajbala Exports Pvt. Ltd. 39, Aya Nagar, Near Pnb ATM, Near Arjan Garh Metro Station, New-Delhi, 110047, India.
5. Menaja Herbal Corp. 106, Sector E, Sanwer Road Industrial Area, Indore, 452115, Madhya Pradesh, India.
6. Mylal exports, 37, Machampalayam road, Sunderapuram post, Coimbatore, 641024, Tamil Nadu, India.
7. Allured Hindfrag, 17/341, 61st Cross Street, New Astc Hudco, Thally Road, Hosur, 635109, Tamil Nadu, India.
8. Industries AG. B-55, Sector-83, Noida, 201305, Uttar Pradesh, India
9. Suman Essential Oils, Kagal, Sangav Road Kolhapur, Karveer Kolhapur, 416216, Maharashtra, India.
10. Rakesh Sandal Industries, 25 Azad Nagar, Kanpur, 208002, Uttar Pradesh, India.
11. Manohar Botanical Extracts Pvt Ltd, Kochi, 682021, Kerala, India.
12. Achisa International Pvt. Ltd., 254 D, Pkt C, Mayur Vihar Ph. Ii, New Delhi, 110091, India.

### Important global consumers of davana oil

1. Alexander essentials Ltd, 55, Yorkshire Street, Morecambe, Lancashire, England.
2. Berje Inc, 5, Lawrence Street, Nj07003, USA.
3. French aroma imports, Inc., 15-58, 127<sup>th</sup> street, 564070, College point, New York.



Different growth stages of davana

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