



## Lavender: A Valuable Aromatic Plant

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*Lavandula angustifolia*, commonly known as lavender, is an aromatic perennial herb of the Lamiaceae family. This plant is highly valued for its essential oil, which is found in its leaves and vibrant flowers. Lavender is primarily cultivated for commercial purposes due to its wide-ranging applications in various products. It is extensively grown across Europe, with Bulgaria emerging as the leading producer of lavender essential oil in recent years, followed by France, the UK, China, India, Spain, Turkey, and others. In India, the Ministry of Science and Technology initiated the "Purple Revolution" or Lavender Revolution to promote an indigenous aromatic crop-based agro-economy through the Aroma Mission of the Council of Scientific and Industrial Research (CSIR). Under this initiative, CSIR-IIIM launched Aroma Mission I in 2016 with the goal of enhancing the income of small and marginal farmers through the cultivation of valuable aromatic plants. Lavender cultivation has been actively encouraged in the temperate regions of Jammu & Kashmir, particularly in Baderwah and Doda districts, where CSIR-IIIM has disseminated high-quality planting material. More than 600 farmers have embraced lavender cultivation across 150 hectares in Jammu & Kashmir under the CSIR-Aroma Mission, thereby generating significant profits.

### Habit and habitat

Lavender thrives in regions characterized by hilly terrain and even snowfall, typically growing at altitudes up to 1700 meters above sea level. Altitude plays a significant role in oil production, with higher altitudes generally favoring cooler conditions that enhance oil yield. In India, lavender is commercially cultivated in Jammu and Kashmir, particularly in areas like Ganderbal, Anantnag, and parts of Srinagar that receive sufficient rainfall. The climatic conditions of Jammu and Kashmir, with cool winters and mild summers, are ideal for lavender cultivation. However, high summer temperatures and humidity can adversely affect the quality of lavender oil. Lavender plants prefer well-drained soils that are light, sandy, or gravelly, with a pH ranging from 5.8 to 8.3. These conditions provide the optimal environment for lavender to thrive and produce high-quality essential oil.

### Morphological features

Lavender is a bushy shrub that typically grows up to 1.2 meters in height, forming a compact and rounded shape. The evergreen leaves are opposite, aromatic, and measure up to 5 cm in length. They are linear or oblong, pinnately veined, and can be either rolled or entire, with bases ranging from cordate to cuneate. Mature leaf blades are scabrous on the upper surface and covered in greyish wool on the lower surface. The flowers of lavender are highly aromatic and are arranged in interrupted spikes. They emit a sweet fragrance and are borne on terminal inflorescences. Each flower is small, fertile, hermaphroditic, zygomorphic, and

attracts pollinating insects. The flowers are pedicellate, meaning they have stalks, and are accompanied by bracts. Lavender produces non-fleshy fruits that are schizocarpic, meaning they split into mericarps when mature. The seeds can vary in whether they contain endosperm or not.

### Chemical constituents and uses

Lavender oil contains several key constituents, including linalool (25.27%), linalyl acetate (44.98%),  $\alpha$ -terpineol (1.49%), borneol (2.7%), camphor (1.07%), lavandulyl acetate (3.4%),  $\beta$ -caryophyllene (1.85%), and caryophyllene oxide (2.08%). During distillation, lavender water is also produced, which holds economic value. Lavender oil is renowned for its pleasant, calming fragrance and has been utilized for centuries for various purposes. It is available in different forms such as absolute, concentrates, and blends. Recognized for its stress-relieving properties, lavender oil is highly favored in aromatherapy. Due to its medicinal properties, the plant is incorporated into numerous pharmaceutical and therapeutic formulations. Moreover, its beneficial effects on skin care have led to a robust market presence in cosmetics, as well as formulations for skin and hair care.

### Cultivation Practices

**Climate and Soil:** Lavender is primarily cultivated in regions with low rainfall and sloped terrain, such as in Jammu and Kashmir, Uttarakhand, and Himachal Pradesh. The plant thrives in well-aerated calcareous soil that is rich in organic matter, with an ideal pH ranging from 5.8 to 8.3. However, lavender can also adapt to less fertile soils.

**Land Preparation:** While lavender is drought-tolerant once established, it requires regular watering during the establishment phase in the field. Lavender grows best in a wide range of climates but thrives optimally at temperatures between 7°C to 21°C. Adequate sunlight exposure is crucial for its growth and should be ensured by proper positioning of the plants.

**Propagation:** Lavender may reproduce itself in two ways: by seeds and vegetatively. Seed reproduction is cheap and quick. However, due to cross-pollination, a great variety of generation forms are observed, which complicates lavender cultivation and harvesting at the most suitable time. Asexual propagation methods are preferred to maintain genetic consistency.

**Vegetative Propagation:** Lavender is propagated vegetatively through cuttings. Cuttings are sourced from annual and biennial branches of the mother plantation. In plains, this is done during October-November, while in hills, it occurs in February-March. Cuttings should measure 8-10 cm in length and have intact vegetative tops. To promote rooting, cuttings are treated with 500 ppm IBA, achieving a 95% success rate. Beds are prepared with a 5 cm layer of organic manure mixed with sand (1:1), topped with 3-4 cm of clean river sand. Cuttings are planted 5 x 5 cm or 4 x 5 cm apart, inserted to a depth of two-thirds of their length. Soil around the cuttings is gently pressed and immediately watered. Polythene covers and mats are used in regions experiencing severe winters to protect the beds.

**Transplanting:** Seedlings, rooted cuttings, slips, or suckers are transplanted at distances of 1.20-1.40 m between rows and 3.5-4 cm within rows. Optimal planting density for high yields is approximately 20,000 plants per hectare.

**Layering:** Layering involves bending a low-growing stem of a healthy lavender plant towards the ground while it remains attached to the mother plant. This encourages roots to form on the stem while still connected.

**Tissue Culture:** Tissue culture is used for mass propagation from selected mother plants, ensuring disease-free and genetically identical offspring. This method is more costly but guarantees uniformity.

**Irrigation:** In commercial lavender cultivation, irrigation is essential during the first 2 years to establish the crop. Particularly in regions with lighter soils and low rainfall, irrigation at

critical growth stages, such as during flower initiation, is crucial. Drip irrigation is highly recommended for lavender cultivation to minimize water wastage and suppress weed growth.

**Weed Control:** Effective weed control in lavender cultivation involves hand-hoeing and mechanical weeding using a tractor-drawn cultivator. Care must be taken to avoid damaging the roots. Mulching with compost and grass helps reduce weed incidence, typically requiring 2 to 3 weeding sessions per year. Utilizing distillation waste as organic mulch can further suppress weed emergence. Intercropping with other plants can also be employed to naturally inhibit weed growth.

**Other Cultivation Practices:** In the initial years, pruning of flower buds promotes full vegetative growth of lavender plants. Pruning is typically done in autumn after harvesting to

**Harvesting:** Commercial lavender production becomes profitable after the second year of plantation and can continue for 12-15 years. Harvesting for essential oil extraction should be timed when the flowers are fully developed and basal branches begin to open, typically around late December to early January. The ideal harvesting period ranges from 4 to 10 days, after which flower and oil quality may decline. Harvesting should avoid hot weather to prevent rapid evaporation of essential oils; if cold weather persists, harvesting can be postponed until conditions are optimal for oil extraction. Flower spikes are typically cut 15 to 20 cm below the flowers using sickles, shears, or other mechanical devices. For fresh and dried flower markets, harvesting usually occurs about a week later compared to oil production, with longer stems preserved for these markets. Dried flowers are valuable for lavender's value-added products alongside essential oil. After harvest, flowers are bundled and dried in the shade. Approximately 8 to 10 kg of fresh flowers are needed to produce 1 kg of dry flowers.

**Sorting and Distillation:** Steam distillation is the preferred method for extracting lavender oil, where distillation temperature is crucial for preserving the oil's valuable constituents. Factors like harvesting season, plant age, and weather significantly influence both oil quantity and quality. Lavender and lavandin concretes can also be produced through solvent extraction from fresh plant material using solvents such as toluene, hexane, or petroleum ether. After solvent evaporation, a residue called concretes remains, which finds use in industries like perfumery, particularly in soaps. Further refinement involves mixing concretes with ethanol, followed by cooling, filtering, and evaporating ethanol to obtain a wax-free residue known as an absolute. Absolutes are widely favored in fine perfumery despite a 50% loss in yield during the transition from concrete to absolute.

**Grading:** Lavender essential oil is graded based on chemical analysis, focusing on the quantity of esters present in the plant. Quality assessment also involves organoleptic evaluation by flavorists, who provide final judgments on aroma and taste, ensuring high-quality standards for lavender essential oil.

**Packaging and Storage:** Lavender oil should be stored in dark, airtight glass bottles to protect it from light exposure, which can degrade its quality. It's crucial to avoid direct exposure to heat and heavy metals to maintain the oil's potency. Properly handled, essential oils can remain potent for 6 months to 2 years. Alternatively, fluorinated plastic, treated aluminum, or dark glass and ceramic containers can also be used for storage. Packaging should be clean and orderly, with clear labeling to ensure product identification and safety.

**Marketing:** Lavender products can be marketed in various forms, including dried flowers, fresh flowers, and processed derivatives. The primary markets for lavender essential oil are the United States, followed by Japan and Europe. As of 2024, the global lavender oil market is valued at US\$ 138.2 million and is projected to reach US\$ 267.2 million by 2034, with an anticipated compound annual growth rate (CAGR) of 6.8% from 2024 to 2034.



Dried Flowers and Various Lavender Products