

Davana Oil

Source, chemistry, and application in flavors and fragrances

Pierre-Jean Hellivan, Vigon International



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Vigon International

Much has been written about the great classic ingredients that dot the palettes of perfumers and flavorists. Surprisingly, however, there are few references to an extraordinary essential oil, davana (*Artemisia pallens*). Its history in the industry is short; first distillations were reportedly conducted in India in the first half of the 20th century, yet it was not until 1970 that exports from India started intensifying, and not until 1985 did davana become a household name marketed to fragrance consumers with the launch of *Davana* by Franka M. Berger.¹ Today, davana remains a small-volume essential oil; the 2010–2011 crop period yielded production of 4,000 kg, according to estimates by Kancor Ingredients. Despite this, the essential oil has earned a special place in perfumers' and flavorists' palettes, particularly in the United States and Japan, where it is a flavor ingredient for bakery, tobacco and beverage applications.²

Cultivation

Davana (*A. pallens*) is an annual branched herb. The plant grows knee-high and looks much like a small fern. It is most fragrant at maturity, when it produces tiny flowers that are rich in essential oils. India is the sole source of *A. pallens*. The crop occurs in its southern tier, Tamil Nadu and Karnataka, with the outskirts of Bangalore producing the largest volumes. Davana does grow well in various types of soil, but does best in the sandy or red loamy soils of south India. It thrives in nutrient-rich black loam with good drainage.

Even though davana can grow year-round, optimal essential oil content is reached only when the plant is allowed to grow through the winter. In the fall, nurseries are busy growing seedlings; usually 1.5 kg of the prior crop's seed will yield enough seedlings to transplant 1 ha. Within six to eight weeks, in early November, seedlings are transplanted from nursery to field. At that stage they are 10 cm tall. Fields are meticulously prepared, with bunds and channels for optimal irrigation and intercultural operations, as is so common in India. Manure is the preferred fertilizer. Upon transplanting, irrigation is fine-tuned based on weather conditions. The art of correctly spacing rows and seedlings within each row is perfected here: spacing of 1 ft between rows and

6 in between seedlings is found to be optimal. Tighter spacing will result in essential oil content reductions. Wider spacing will result in taller plants with less herbage and less oil. The plant is rather sensitive to weather; a moderate sun-filled winter condition with no frost and moderate showers fosters the most favorable conditions for the growth of davana. On the other hand, higher temperatures and excessive rains will inhibit its development and impact its essential oil content.

Four months are required to allow davana to fully mature. Harvesting is done by hand, cutting the plant at its base with a sickle, at a rate of 10–12 tons/ha. Precisely 110 to 115 days after sowing, davana is in bloom,



Cultivation of davana in southern India; photo courtesy of Sreekala Nair, Kancor Ingredients.

the telltale sign that the crop has reached its optimal essential oil yield. It is indeed the flower heads of davana that hold the largest amounts of oil. Harvest is precisely timed with the bloom, usually starting in late February, reaching its peak through March and early April. Best yields and quality of oil are obtained from plants cut just before the flowers open completely. Laboratory tests confirm that the major portion of the essential oil is held in the flowers: twice as much oil is held in the flower heads alone, compared to leaves and stems. One often witnesses early pre-bloom harvest, but this early crop is destined for the Indian flower markets for garlands and bouquets.

Distillation and Chemistry

Steam distillation is the preferred extraction process for davana. The raw material is the freshly harvested herb, processed whole, but allowed to dry somewhat before distillation. The drying period ranges from two days to one week, depending on weather conditions, plant moisture upon delivery to the distillery and the processor's specific habits. Kancor Ingredients reports that, under laboratory conditions, the oil content of the whole plant is as high as 0.29%. Large scale distillation normally achieves a recovery rate of 0.2%, translating into 12–13 kg of oil/ha. R.N. Kulkarni of the Central Institute of Medicinal and Aromatic Plants in Bangalore reports, "The oil is distilled at a pressure of 1.0–2.0 kg/cm² for 10–15 hours; the bulk of the oil is, however, distilled in about 8 h. The recovery of the oil from the semi-dried herbage is generally 0.2%."¹ In terms of processors, rudimentary farm-level stills share the annual output with much larger scale distillation operations. To help separate the oil from the distillate water, a saturated solution of sodium chloride (salt) is often used.

Davanone, a sesquiterpene ketone, is the major component and quality driving factor of davana oil (**F-1**). High-quality material usually boasts a davanone content at or above 50%. Grades around 45% will usually be offered at a discount. Nerol is present at 10%, while geraniol is found at 5%. Surprisingly, its largest component, *cis*-davanone, has been shown to be odorless.³ Davana's signature aroma actually comes from davana ether, davana-furans, dihydrofurans, dihydrorosefurans, *trans*-hydroxy

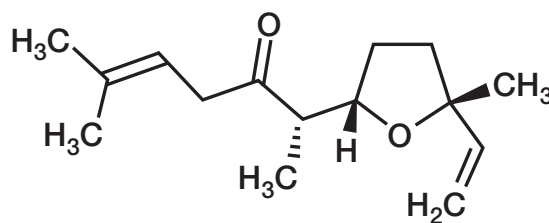


Davana seedlings; photo courtesy of Sreekala Nair, Kancor Ingredients.

Davanone

F-1

39



davanone, hydroxy dihydrorosefuran and furano-nor-diterpenoid blended with cinnamyl cinnamates—even though they are all found at less than 2% in the oil.

Lawrence reported that in 1991 Misra et al. identified the following compounds in lab-distilled dried davana (**T-1**).⁴ The risk of adulteration of the oil grows as market prices rise. Quality control procedures should include testing for undesirable additives such as vegetable or fixative oils.

Sensory Characteristics

Davana's reddish brown essential oil boasts a potent, exquisite scent. Its character is shockingly reminiscent of old spirits like cognac, with sharp, dry fruit notes, and a full body with thick honey herbaceous notes. Perfumers

appreciate its rich blackcurrant top complementing wood and hay notes, drying down fruity winey with the depth of tobacco.

Davana is first and foremost a flavor ingredient. Chief flavorist Chris Williams (WILD Flavors) describes a blotter as “floral woody fruity and seedy with dark undertones.” When questioned on the cognac-like character, Williams replies, “Yes, it comes from that woody character of cedar wood and oak, reminding indeed of oak alcohols such as bourbon and whiskey.” Upon tasting the oil in solution, Williams notes “the pleasant fruity taste of grape and apple.” A davana sensory chart is depicted in **F-2**.

Fragrance Application

Fine fragrance perfumer Ilias Ermenidis (Firmenich) began using davana with *Givenchy Pour Homme* and *Givenchy Pour Homme Blue Label*. Since that time, it became one of his favorite ingredients in men's fragrances. “Every single of one of my men's formulas contains davana,” says Ermenidis. “At low levels, it adds an impressionist finishing touch.” Ermenidis describes davana as reminiscent of champaca, fruity herbaceous, aromatic, almost woody, with a penetrating alcohol side like whiskey. “Davana marries well with ozone notes, and provides warmth to aquatic fragrances,” he says. “It adds dimension and tames the sharp edge of woody notes.”

Senior perfumer Shere Rolo (Trilogy Fragrances) pours her creativity mainly in the niche markets of natural fragrances for personal care and air care. “For me, davana is almost plum, a very deep plum, with a rosy preservelike character,” she says. “Considering the sky-high cost of natural rose ingredients such as rose oil or phenyl ethyl alcohol natural, I find davana very useful as a rose replacement type when blended with geranium oil. It will greatly deepen the rosy character of geranium, and yield a natural poor man's rose oil.” In rose formulations, davana is used to round the fragrance, to tame the minty metallic edge of geranium; it is used more for its low-dosage effect than for its character itself. To deliver

Compounds found in a lab-distilled dried davana⁵

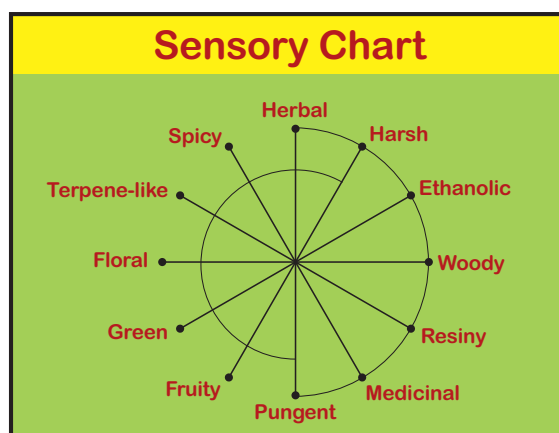
T-1

| Components | % |
|---------------------------------|-------|
| <i>cis</i> -davanone | 38.0% |
| <i>trans</i> -davanone | 5.0% |
| isodavanone | 3.0% |
| <i>cis</i> -hydroxy-davanone | 2.0% |
| <i>trans</i> -hydroxy-davanone | 2.0% |
| nerol | 10.0% |
| geraniol | 5.0% |
| dihydro rosefurane | 2.5% |
| dihydrofurans | 2.5% |
| davanic acid | 2.5% |
| furano-nor-terpenoids | 2.0% |
| α -nor-diterpenoid furan | 2.0% |
| cinnamyl cinnamate | 2.0% |
| dihydroneolidol | 2.0% |
| artemone | 1.5% |
| nor-davanone | 1.5% |
| davana ether | 1.5% |
| a sesquiterpene alcohol furan | 1.5% |
| hydroxy nerolidol | 1.2% |
| <i>trans</i> -davanafuran | 1.0% |
| davana esters | 1.0% |
| davanol | 0.8% |
| p-cymene | 0.8% |
| γ -cadinene | 0.8% |
| ethyl davanate | 0.7% |
| <i>cis</i> -davanafuran | 0.5% |
| hydroxy dihydrorosefuran | 0.5% |
| linalool | 0.5% |
| borneol | 0.5% |
| lilac aldehyde | 0.5% |
| linalool oxide | 0.5% |
| lilac alcohol | 0.5% |
| hydroxydihydrose furan | 0.5% |
| farnesol | 0.5% |
| 8-oxoerolidol | 0.5% |
| camphene | t |
| sabinene | t |
| nor-davana ether | t |

t = trace (<0.05%)

Davana sensory chart⁵

F-2



natural plum notes, Rolo also relies on davana. It is a useful tool to imitate the effect of synthetic dimethyl benzyl carbonyl butyrate, and the former bases *Mirabelle 2000* or *Prunella*. Rolo cautions, however, that “in natural perfumery one never speaks of natural duplications for the synthetics; instead we talk of natural renditions.”

Flavor Application

Senior flavorist Brigitte Pellen (Firmenich) relies on davana for a wide range of fruity notes. “The main tonalities where it contributes the best are red fruits, berries like strawberry or raspberry,” she says. In addition, she reports interesting applications in beverage flavors. “Due to its herbal, dry notes, it fits also fantasy compositions like cola, enhancing cola for confectionary orientation, giving a dry, somewhat herbal note,” says Pellen.

“Another suitable fantasy tonality, typical of Europe, is grenadine.” She has also noticed davana’s performance in dried fruit flavors such as fig, prune or date: “When davana is used at a low level it gives roundness and contributes to the typical dried fruit character.”

Williams recommends careful dosage to remain below astringency thresholds and prevent the davana character from becoming overwhelming or too prevalent. “I use davana in all types of fruit flavors, mostly for berries like strawberry, raspberry, for cassis (blackcurrant), but also for white grape,” he says. “Also, davana adds seediness and helps me round out the flavor.”

In the art of flavoring tobacco, essential oils are key building blocks in the development of unique aroma systems and product differentiation. Tobacco flavorists incorporate davana oil in their flavor systems to enhance the natural flavor characteristics of tobacco in their

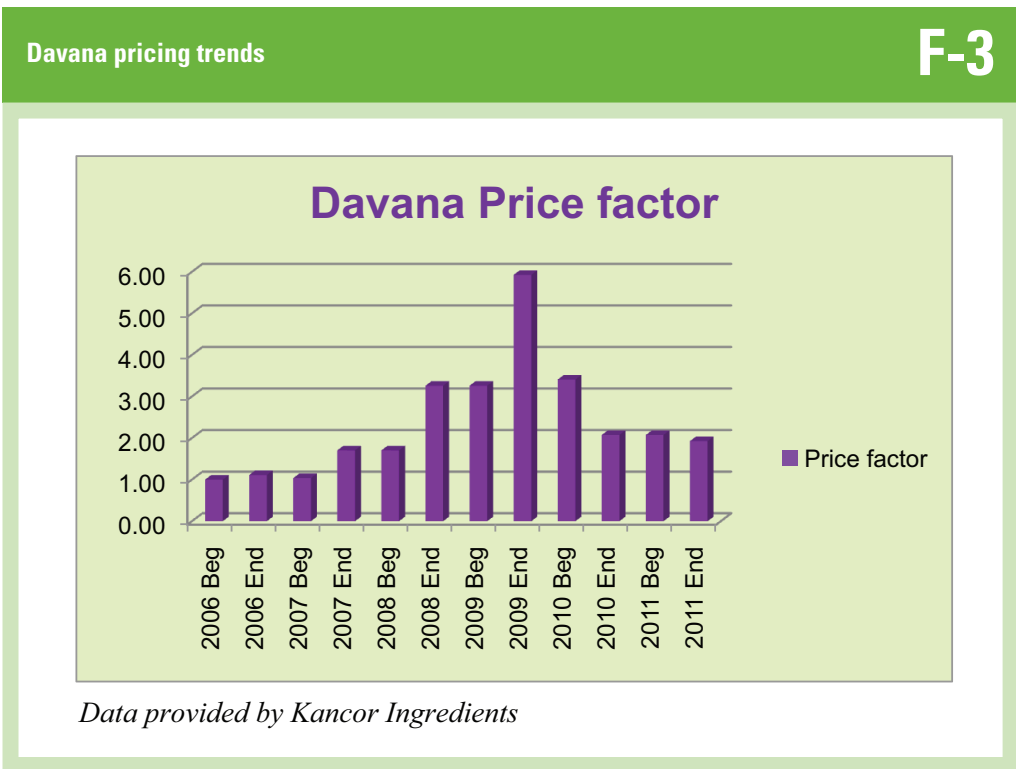
development of what the US Food and Drug Administration calls “non-characterizing” flavor systems. The aromatic essence of davana oil is multifaceted, with a unique composition of furanoid sesquiterpenes. For tobacco flavorists, documenting its tenacious aroma and flavor contribution is an ever-changing experience with each dilution. In higher concentrations davana exudes sweet-balsamic-woody-winey notes reminiscent of flue-cured tobacco. In dilution, more subtle essences of fermented dried fruit emerge. Learning to control the tenacity of this essential



Harvesting of davana; photo courtesy of Michael Dube.

oil through dilution poses both a challenge and a sense of accomplishment.

Senior flavorist Jack Rothenhoefer (Tobacco Technology) likes to use davana oil to boost tea and fresh tobacco notes. “There are no aroma chemicals like it, no substitutes” he says. “A little will go a long way. Beyond tobacco notes, davana also has the functional benefit of a salivating effect. It will not cover off-notes, but it does blend very well. It is a great taste/flavor modifier and tobacco booster. I successfully used davana to complement damascenone, or as an ingredient to replace damascenone.” Interestingly, when questioned about trendy spirits flavors in the cigar industry, Jack stressed that davana’s cognac character is not useful here; rather, synthetic esters are a more cost-effective option. He adds, “Unlike similar ingredients like boronia or osmanthus absolutes, I never experienced availability issues with davana oil.”



Market Dynamics

After a decade of relative stability, the market dynamics of davana oil went out of balance (F-3). The fragile equilibrium of supply and demand—always challenged by poor crops, high demand and inventory positions—rocked davana market prices. In 2008, demand was reported to have nearly doubled, just when difficult weather conditions yielded the poorest crop in years. Prices increased sixfold, with many buyers settling for poor-quality, low-davanone oil. Interestingly, Kancor Ingredients reports that it was during the highest priced season of 2009 that exports doubled from 4,000 kg to 8,000 kg. Motivated by a perceived growing demand and sky-high prices, local farmers and major processors increased acreage. Subsequent crops delivered ample supply in a depressed economy, yielding much carryover stock. In 2011, in which weather conditions have been less than ideal and crop output much below expectation, carryover inventories helped keep market prices in check. Kancor Ingredients reports: “Currently, about 1,500 acres of land



Davana harvested pre-bloom is destined for the Indian flower markets for garlands and bouquets; photo courtesy of Michael Dube.

is under davana cultivation, but accurate data is not available as to the historic acreages.”

Shedding the sustainability spotlight on davana reveals interesting facts. While areas of improvements will always be found under the economic and social pillar, it is the ecological pillar that deserves the most attention. On the positive side, the crop is cultivated, not wild. Fertilization is from poultry manure, not chemicals. The crop is mostly free from pests, and usually does not require pesticides. Some farms have fallen victim to leaf-eating caterpillars and termites and may employ systemic or contact insecticide.⁶ However, one concern stands out: water (F-4). Davana is a thirsty plant. Proof is in the accounting: watering accounts for nearly 20% of the cost of its essential oil.⁹ Furthermore, its growing region is experiencing declining water levels, and no major irrigation projects are underway. Sourcers sensitive to sustainability should therefore zero-in on this specific risk, and bring aggressive water conservation programs to these farms. Some farms do take advantage of the nearly 10 mm of monsoon rains by collecting rain water, and thereby greatly reduce their ground water consumption.

Conclusion

Opportunities for continuous improvement of davana management are wide open: better botanical selections for increased extraction yields, better understanding of supply demand acreage and carryover inventories for calmer market dynamics, and creation of clear physico-chemical standards to define and promote higher quality. Nature creates an endless bounty of tools for perfumers and flavorists. Nothing smells like davana. Is it not time for our creators to give it more justice?

Acknowledgements

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| Farming cost | Share of total cost |
|-----------------------|---------------------|
| Seed and nursery | 15% |
| Labor | 54% |
| Plant protection | 0% |
| Watering | 18% |
| Manure and fertilizer | 12% |

those who asked to remain unnamed for their comments. Special thanks to Kancor Ingredients CEO Gemon Korah and key accounts manager Sreekala Nair for contributing very detailed agricultural and market dynamics data. Access to the Firmenich library at its Grasse-based naturals business unit was arranged by marketing manager Virginie Gervason. Finally, thanks to Stephen Somers Sr., president of Vigon, for supporting the time efforts and resources required for this article.

Address correspondence to Pierre Hellivan, Vigon International Inc., RR2 Box 2093, Airport Road, East Stroudsburg, PA 18301-9629; phellivan@vigoninternational.com.

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