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Report on production of value-added product from Jasmine

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Department of Science & Technology
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Background

Jasmine, belonging to the genus *Jasminum*, represents a diverse and widespread group of flowering plants within the family Oleaceae. Introduced in the mid sixteenth century, these aromatic woody shrubs or vines are renowned for their ornamental and fragrant qualities, making them a subject of interest for horticulture and botanical enthusiasts alike. *Jasminum auriculatum, Jasminum grandiflorum,*and *Jasminum sambac* are three significant species that are frequently cultivated for commercial purposes.

Appearance

Jasmine flowers are typically small, tubular, and have a distinct star-like shape. They are usually white or yellow, although some species may have pink or red blossoms. There are cultivars and species that trail, climb, and grow erectly. Their spreading or climbing growth patterns are frequently encouraged by careful trimming and supports like trellises.

Soil & climate

Jasmine can be grown on a variety of soils. Their cultivation requires rich, loamy soil that drains well and has a pH between 6.5 and 7.5. Jasmine grows best in climates with mild winters, warm summers, moderate amounts of precipitation, and sunny days. The ideal annual rainfall for growth and development of jasmine is between 800 and 1000 mm.

Area under cultivation in India

In India, the leading states in jasmine cultivation are Karnataka and Tamilnadu. Jasmines are cultivated throughout the country but the commercial cultivation is confined to Coimbatore, Madurai, and Dindigul (Tamil Nadu); Mangalore, Udupi, Bangalore, Bellary, Mysore and Kolar (Karnataka); Kannauj, Jaunpur and Gazipur (Uttar Pradesh); Udaipur, Jaipur, Ajmer and Kota (Rajasthan); Ranaghat, Kolaghat, Pancskura (West Bengal); parts of Andhra Pradesh and Maharashtra.

Cultivation & propagation

In India, jasmine is commercially grown in open fields and grows up to 1200m. Layering and cutting are the main propagation methods. Better rooting of cuttings can be obtained by planting in coarse sand and also by using any of the rooting hormones like Indole-3-butyric acid (IBA) (5000 ppm), Indole-3-acetic acid (IAA) (1000 ppm) and 1-Naphthaleneacetic acid (NAA) (5000 ppm). Simple and compound layering methods are followed during June-July to October-November. Layers will be ready for planting within 90-120 days.

Characteristic differences between species of Jasmine

Characteristics	*Jasminum sambac*	*Jasminum grandiflorum*	*Jasminum auriculatum*	*Jasminum multiflourm*
Flower	White, small, waxy, star-shaped	White or yellow, large, star-shaped	White or yellow, medium-sized, star-shaped	White, Stellate / Star-shaped
Growth Habit	Shrub or vine	Shrub or vine	Climbing vine or shrub	Branching vine/ shrub
Fragrance	quite sweet soothing fragrance	a soft floral scent	alluring and musky aroma	Very mild scent
Fragrance causing chemicals (Headspace analysis)	farnesene, benzyl acetate and linalool	jasmone, benzyl acetate, farnesene and linalool	jasmone, benzyl acetate, farnesene and linalool	Methyl benzoate, Benzyl acetate, nerolidol, indole, jasmone, limonene and linalool
Native Range	Southeast Asia, India	South Asia, China, Africa	India, Sri Lanka	India and south eastern Asia

Jasmine species in India

The genus *Jasminum* contains 200 species, however there are only 89 true species within it. Total of 40 species of jasmine are cultivated in India, among which 20 species are cultivated in south India. Numerous species that are found in the wild in India have the potential to be a source of variability or the development of new varieties. Having chromosome number n=13, the majority of jasmine species are diploid, but some of them, particularly *Jasminum sambac* (2n=39), *Jasminum flexile* (2n=52), *Jasminum mesnyi* (2n=39), and *Jasminum angustifolium* (2n=52), are naturally polyploid. Scientific publications reveal that India boasts a rich diversity of jasmine species. Few to mention are: Star Jasmine (*Jasminum multiflorum*),Juhi (*Jasminum auriculatum*),Chameli or Spanish Jasmine (*Jasminum grandiflorum*), Mogra or Arabian Jasmine (*Jasminum sambac*) Common Jasmine (*Jasminum officinale*), Yellow Jasmine (*Jasminum humile*), Star Jasmine (*Trachelospermum jasminoides*), White Jasmine (*Jasminum polyanthum*), Cape Jasmine (*Gardenia jasminoides*), The Night-Blooming Jasmine (*Cestrum nocturnum*), Wild Jasmine (*Jasminum fruticans*), Primrose Jasmine (*Jasminum mesnyi*) etc. Four varieties of jasmine in India have been given GI tag.

1. Madurai Malli
2. Mysore Malligae
3. Udupi Malligae
4. Hadagali Malligae

1. Madurai Malli (*Jasminum Officinale*)

Madurai malli is cultivated widely in the districts of Madurai and other neighbouring places like Virudhunagar, Theni, Sivaganga and Dindigul. The flower is known for its heavy fragrance as well as its thick petals which change colour from greenish white in the morning to milky white in the afternoon to creamy white with a slight silvery shade by evening. The colour of the flowers as well as its fragrance last for two days. This longer shelf life of Madurai Malli, which is due to its thicker petals as well as its longer petiole, makes it attractive for the consumers, especially exporters and flower weavers. The heavy fragrance of the flower is a result of the accumulation of alkaloids such as ‘jasmone’ and ‘alpha terpineol’. These alkaloids accumulate owing to the topography of the Madurai region where the flowers are harvested.

Three varieties are from Karnataka

2. Udupi Mallige *(Jasminum sambac)*

The Udupi Mallige (*Jasminum sambac*) is of recent origin and the first cultivation of this variety started in Shankarapura in Udupi district about 100 years ago. Therefore, it is also called Shankarapura Mallige. This variety has demand in Mumbai, Goa, Nasik and other places. This has a longer shelf life and its bud remains for three to four days. Udupi Mallige is rated to be more economically viable among all the three varieties. The laterite soil condition of the coast, high humidity and heavy rainfall (more than 2,500–3,000 mm or 98–120 inches per annum) makes it suitable for growing this crop.

3. Hadagali Mallige *(Jasminum azoricum)*

Hadagali Mallige (*Jasminum auriculatum Vahl*), locally known as "Vasane Mallige ", is grown mainly in Hoovina Hadagali, Hospet and surrounding areas in Bellary district. The Hadagalli variety is unique as it grows on sandy red soil prevailing in this region. The dry weather and good water supply are needed to this variety which is mainly propagated through cuttings. It is planted directly in July and August or at the onset of monsoon. The flowering season spreads up to six months.

4. Mysore Mallige *(Jasminum trifoliatum)*

Mysore Mallige is mainly grown around Mysore and partly in Srirangapatna taluk in Mandya district. Mysore Malligae, Udupi Malligae, Hadagali Malligae: jasmine gives fragrance due to the presence of aromatic compounds such as Indole, Jasmone, Benzyl Acetate, Benzyl Benzoate, Methyl Anthranilate, Linalool and Geraniol.

Jasmine species in coastal belt

In the coastal belt of Karnataka, 3 main ecotypes of *Jasminum sambac* are cultivated commercially for its flowers. Three districts of coastal Karnataka comprising Uttar Kannada, Udupi and Dakshina Kannada are well known for jasmine cultivation. A distinctive morphological diversity is observed among jasmines cultivated in these 3 districts of coastal Karnataka. On this criteria, jasmine cultivation in coastal Karnataka are classified into three different ecotypes namely, **Bhatkal mallige** cultivated in Uttara Kannada district, **Udupi mallige** in Udupi district and **Mangaluru mallige** in Dakshina Kannada district. The jasmine

flower is mainly grown commercially in these areas for adorning hair, decorations during religious ceremonies and also in the perfume industry.

Buds are preferred over fully bloomed flowers

The preference for jasmine buds over fully bloomed flowers is a common practice in many cultures and is supported by scientific observations and findings:

- **Higher Concentration of Fragrance Compounds:** Scientific studies have shown that jasmine buds tend to contain a higher concentration of volatile fragrance compounds than fully bloomed flowers. (R)-(-)-Linalool was found as major enantiomer in volatiles of floral buds whereas (S)-(+)-linalool predominated in the volatiles of matured flowers. The successive enantiomeric changes from (R)- to (S)-linalool ratio from bud to mature flower is mainly due to the enantio- specific transformation and temporal decline of (R)-linalool producing gene in *J. grandiflorum* and will lead to the difference in flower aroma.
- **Extended Shelf Life:** Jasmine buds have a longer shelf life compared to fully bloomed flowers, primarily due to their lower metabolic activity. This makes them more suitable for use in garlands, perfumery, and other applications.
- **Cultural and Aesthetic Reasons:** The use of jasmine buds is often preferred for cultural and aesthetic reasons. The closed buds are considered more visually appealing and are associated with purity and freshness in various cultural practices.
- **Ease of Handling:** Jasmine buds are easier to handle and thread into garlands or use in perfumery due to their compact size and closed petals.
- **Conservation of Fragrance**: By using buds, the fragrance is conserved until the moment of use, providing a burst of fresh fragrance when needed.

Jasmine concrete and absolute

Jasmine does not yield an oil by steam distillation, i.e. jasmine essential oil, as defined by ISO 3218 "Essential oils. Principles of nomenclature," does not exist as a commercial product. Jasmine extract solutions in e.g. di-propylene glycol or isopropyl mirystate are incorrectly called "jasmine oil." The most common extraction, involves a two-step method where hexane is first used to extract "**jasmine concrete**" (a solid, waxy-buttery product made of oil and wax) from the blossoms. The concrete is ultimately either commercialised or converted by the jasmine concrete producer into "**jasmine absolute**," a liquid oil, free of waxes. This is performed by washing the concrete numerous times with ethanol at negative temperatures to

allow the soluble fraction on the concrete to dissolve into the ethanol, while preventing the flaking wax from doing so and easily removing it by filtration. The ethanol-absolute solution is then distilled to separate one from the other. Jasmine absolute obtained is used in perfumery as raw material.

Techniques of jasmine fragrance extraction

Jasmine fragrance has widespread applications in conventional and end use segment. It can be used as antidepressant, antiseptic, antispasmodic, and expectorant for dry skin, labour pains, cough, headache, depression, exhaustion, and sensitive skin. Jasmine needs solvent extraction since it is too fragile to be distilled and has a very low volatile oil content. Therefore, the essential aromatic components are extracted using chemical solvents like hexane and supercritical CO_2.

1. **Enfleurage Method:** This traditional method involves enfleurage, where the flowers are placed on glass plates coated with fat or oil. Over time, the scent diffuses into the fat, which is then dissolved in alcohol to create the fragrance.
2. **Solvent Extraction:** This method involves using a solvent, typically hexane, to extract the fragrance from the flowers. The solvent is then removed, leaving behind the jasmine absolute, which is a highly concentrated fragrant material used in perfumery.
3. **Steam Distillation:** This is a common method used to extract essential oils from various plants. In this process, steam is passed through the jasmine flowers, which helps in releasing the essential oil. The steam containing the oil is then cooled and condensed, separating the jasmine essential oil from the water.
4. **Molecular Distillation:** This method involves using molecular distillation equipment to isolate and purify the jasmine fragrance compounds. It's often used for high-end fragrance extraction processes.
5. **Hydro-distillation:** This method is similar to steam distillation but involves the use of water instead of steam. The jasmine flowers are immersed in water and then heated to release the fragrance, which is then captured and separated from the water.
6. **Supercritical Fluid Extraction/ CO_2 Extraction (SCFE):** This modern technique involves using supercritical carbon dioxide to extract the essential oil from the jasmine flowers. This method is considered environment friendly and produces high-quality extracts.

The traditional methods of obtaining extracts like steam distillation and solvent extraction—are in fact being replaced. A contemporary method of extraction used is supercritical fluid extraction (SCFE). It works by manipulating the supercritical liquid state's response to changes in temperature and pressure. Mostly, supercritical fluid extraction utilizes CO_2 because of its physical properties of moderately lower pressure and temperature conditions (304 K and 7.38 MPa, respectively). Additionally, this method's yield is said to be higher than those from hydro-distillation and steam. Products extracted using this technology have the advantages of purity, high concentration and extended shelf life. This process allows flexible operating conditions for multiple product extraction and simultaneous fractionation of extract. It also eliminates toxic residues.

However, the biggest drawback of SCFE is its high hardware cost, which prevents it from being used for extremely mechanical parameters. In comparison to conventional procedures, the approach yields a higher and better recovery of scents in a single step. The SFE pilot plant has one CO_2 tank, heat exchanger, gas booster, one extractor and one separator vessel.

The SCFE include following steps:

CO_2 conditioning, extraction process and extract recovery. The CO_2 acts as a solvent on the natural plant matter, drawing the oils and other compounds like pigment and resin from it. The liquid CO_2 then dissolves the essential oil component. The resultant oil is what remains after the CO2 is returned to its natural pressure and turns back into a gas. In order to extract the scents/oils from the jasmine flowers, supercritical fluid CO_2 is charged into an extractor that is filled with the flowers from the bottom. Carbon dioxide under pressure becomes liquid while still being a gas, which is when it is said to be "supercritical." The extractor is then left in a static state for a predetermined amount of time. As fresh supercritical fluid CO_2 is charged into the extractor for a predetermined amount of time at a predetermined pressure and temperature, fragrance-laden CO_2 is slowly released from the top of the extractor. By depressurizing the CO_2 from the extractor's top that is loaded with fragrance, perfumes from the extractor are then recovered in a separator. The procedure is repeated in order to complete the cycle of extracting static smells from flowers and collecting dynamic perfumes. Prior to extraction with supercritical fluid CO_2, the flowers may also be treated with a water-soluble organic co-solvent for an even better and higher recovery.

The difference between standard distillation and supercritical extraction is that the latter uses CO_2 as a solvent in place of heated water or steam in the former. Steam distillation takes place at temperatures between 60°C and 100°C, whereas the supercritical extraction process operates between 35°C and 50°C. The temperature used during steam distillation alters the molecular

makeup of both the plant material and the essential oil. A CO_2 extract, on the other hand, contains a larger variety of the plant's elements and is chemically more similar to the source plant. The selectivity or solvent power of CO_2 is adjustable and can be set to values ranging from gas-like to liquid-like, which is an advantage of employing supercritical CO_2. The petrochemical residues in the solvent-extracted product can also be avoided using this technique.

Supercritical fluid extraction – Components, Process and Costings

Supercritical fluid extraction (SCFE) is the process of separating one component (extraction) from the other (matrix) using supercritical fluids as extracting solvent. The extraction is carried out by a solvent above its critical pressure and temperature. Products extracted using this technology have the advantages of purity, high concentration and extended shelf life. This process allows flexible operating conditions for multiple product extraction and simultaneous fractionation of extract. It also eliminates toxic residues. Carbon dioxide and water are the most common solvents used in SCFE. CO_2 is widely used as a solvent in SCFE due to its relatively low critical point (73 atm and 31°C), extraction properties, availability, gaseous natural state and safety.

SCFE plant 1 x 20L capacity

List of equipment:

- Extraction vessel with pre-heater - 20L
  - Back Pressure Regulator (BPR)
- Medium pressure collection system
  - Medium pressure separator
  -Back Pressure Regulator (BPR)
- Low-pressure collection system
  -Medium pressure separator
  -Back Pressure Regulator (BPR)
  -Electrical vapourising heater
- CO_2 recycling system
  - CO_2 receiver tank with condenser heat exchanger
- Pre-cooler heat exchanger
- High-pressure CO_2 pump
- High-pressure co-solvent pump
- Brine chiller

With,

- Polyurethane paint-coated support skid with stainless steel floor for pilot SCFE system having above equipment,
- Piping, fittings, isolation and control valves for process and utility fluids,

- State-of-the-art computerized PLC-based instrumentation and control system with independent control panel,
- Safety features like pressure relief valves, rupture disks, pressure switches, smart pressure transmitters, and interlock logic software, etc

Equipment details:

High-pressure extraction vessel with pre-heater

- Useful volume: 20L
- Max operating pressure: 400 Bar
- Material of construction: parts in contact with CO_2 made of SS-316
- With quick-acting closure for easy opening and closure.
- Inner surfaces and parts subjected to polishing to achieve easy-to-clean feature
- With perforated feed holder with internal 'useful' volume of 20L for easy handling and loading of the feed and efficient extraction.
- Design as per ASME code, section VIII
- Inspection/ acceptance from reputed third-party inspection agency.

Automated high-pressure BPR (Back Pressure Regulator)

- Type: electrically actuated with the driver card.
- Max. operating pressure 400 Bar
- It has heaters and an independent temperature controller to compensate for cooling due to the 'Joule -Thomson effect' during operation (expansion).
- The pressure sensor on the upstream side provides closed-loop feedback for control and pressure alarm monitoring

Medium pressure collection system

Medium pressure separator

- Volume:4L
- Design pressure: 165 Bar
- Design Temperature: 100°C
- Material of construction: parts in contact with CO_2 made of SS-316
- With quick-acting closure for easy opening and closure of the vessel.

- With specially designed internals for high collection efficiency and avoiding loss of extract to entrainment.
- Inner surfaces are subjected to polishing to achieve easy-to-clean features.
- With an electrically heated jacket for temperature control
- Design as per ASME code, section VIII
- inspection/ acceptance from a reputed third-party inspection agency

Automated Medium Pressure BPR (Back Pressure Regulator)

- Type: Pneumatically actuated with and I/P positional.
- Design pressure: 165 Bar
- It has heaters and an independent temperature controller to compensate for cooling due to the 'Joule-Thomson effect' during operation (expansion).
- The pressure sensor on the upstream side provides closed-loop feedback for control and pressure alarm monitoring

Low-pressure collection system

- Low-pressure separator with vapourising heater
- Volume:4L
- Design pressure: 85 Bar
- Design Temperature: 100°C
- Material of construction: parts in contact with CO_2 made of SS-316
- With quick-acting closure for easy opening and closure of the vessel.
- With specially designed internals for high collection efficiency and avoiding loss of extract to entrainment.
- Inner surfaces are subjected to polishing to achieve easy-to-clean features.
- With an electrically heated jacket for temperature control
- Design as per ASME code, section VIII
- inspection/ acceptance from a reputed third-party inspection agency

CO_2 recycling system

CO_2 receiver tank with condenser heat exchanger

- Volume:40L
- Design pressure: 85 Bar

- Max operational temperature: up to 40°C
- Material of construction: parts in contact with CO_2 made of SS-316.
- With a jacket for temperature control covered
- With CO_2 level transmitter
- Design as per ASME code, section VIII
- Inspection/ acceptance from a reputed third-party inspection agency

Pre-cooler heat exchanger

- Type: shell and tube hear exchanger
- Material of construction: parts in contact with CO_2 made of SS-316.
- Design pressure: 85 Bar
- Cooling fluid: brine (ethylene glycol + water) at -15°C

High-pressure CO_2 metering pump

- Type: high-pressure plunger pump
- Fluid: food-grade liquid CO_2
- Max operating pressure: 400 Bar
- Min suction pressure: 50 Bar
- Flow rate (max): 40 Kg/hr
- Material: parts in contact with medium in stainless steel,
- Stuffing box in PTFE or any suitable material for liquid CO_2
- Complete with base frame, electric motor, drive, and frequency inverter for pump speed control.
- Additional features: pump controlled using a programmable logic controller (PLC) system with a Graphical User Interface (GUI) via a desktop computer

Coriolis mass flow meter

- Type: high-pressure Coriolis mass flow meter with output independent of pressure and temperature of CO_2.
- Max operating pressure up to 80 Bar

<u>High pressure Co-solvent metering pump</u>

- Type: high pressure plunger pump

- Max. operating pressure: 400 Bar
- Min. suction pressure: 1bar
- Flow rate(max): 4L/h
- Material: parts in contact with medium in stainless steel,
- Stuffing box in PTFE or any suitable material for food-grade application.
- Complete with base frame, electric motor, drive, and frequency inverter for pump speed and flow rate control.
- **Additional features:** pump controlled using a programmable logic controller (PLC) system with a Graphical User Interface (GUI) via a desktop computer.

Brine chiller

- Type: electrically operated, air-cooled package brine chiller
- Brine: ethylene glycol+ water
- Heat duty: 3 TR
- Min. operating temperature: -15°C with accuracy of +/- 1°C
- Brine flow rate: 0.5m^3/h at 3 Bar pressure

- Self-supporting construction
- Independent control panel,
- Secondary tank with circulation pump
- Instrumentation and safety devices,
- Piping system with isolation valves

Control system

It consists of a control panel with state of an art stand-alone PLC-based control system that interacts with a computer system through Human Machine Interface (H.M.I) software. This allows remote monitoring. Recording and control of the operating parameters as well as the implementation of fail-proof safety interlocks to take care of large deviations from the set points or any unexpected/ undesirable situations during SCFE plant operation.

The control system would facilitate a semi-automatic operation requiring minimal operator units. The HMI system will consist of several screens representing different sections of the SCFE process. All process variables such as temperatures, pressures, CO_2 flow tare would be displayed on these screens. The system setpoint values can be configured from these screens. Graphic display screens would also consist of soft pushbuttons per operations of critical

equipment as well as alarm annunciation graphic screens to provide convenient visual indications of faults. The facility for plotting trends of change in operating parameters and recording batch/ event history would also be available.

Instrumentation

- Modern smart pressure transmitter for accurate pressure monitoring and control over a wide range of operating conditions and pressure gauges for local conditions.
- High-pressure-temperature transmitters for direct measurement for control of process fluid temperatures.
- Accurate mass flow monitoring system for CO_2
- CO_2 level transmitter for CO_2 day tank
- Electrically operated control valves (high and low pressure) for control of pressure and temperature of CO_2 at a different section of the main SCFE plant
- Pressure release valves/ rupture disks, pressure switched and interlock logic software for safety interlock

Prices (approximate)

The price for the supply of 1 x 20L extractor capacity pilot scale supercritical and utility is **Rs.1,22,00,000/-** (approx. One crore twenty-two lakh rupee).

Detailed SCFE Process

Liquid carbon dioxide from the container is pressurized by the pump and heated to the extraction temperature by the heat exchanger. Pressurized carbon dioxide flows through the extraction vessel and dissolves the soluble extract. Carbon dioxide loaded with the extract is then flashed in the pressure release valve and carbon dioxide, now in the vapor and liquid phase, flows into the separator, where the liquid fraction is vaporized by heating. The extract is not soluble in carbon dioxide vapor and can be removed from the bottom of the separator. Carbon dioxide vapor is condensed and returned to the container. A heat pump system can be installed to transfer heat from the condenser to the separator. The largest plants use batch extraction vessels with volumes up to tens of cubic meters. The flow rate of carbon dioxide in the largest plants is several tons per hour and the operating pressures are usually within 200–300 bars.

Advantages of SCFE

1. SCFE process has inbuilt features, that improve the quality of extracts yielding superior products.
2. SCFE yields nearly forever-lasting extracts with delicacy and freshness close to natural fragrances, flavor, and taste
3. High concentration of a desired active component, preserving the synergistic bioactivity of molecules in the extract
4. No residual solvent
5. Free of biological (microbial) contaminants
6. Longer shelf life superior processes
7. Simultaneous fractionation of extract
8. SCFE eliminates the use of hexane and methylene chloride as solvents that cause emissions in industry

Disadvantages of SCFE

Though Super Critical Fluid Extraction helps in achieving improved results, it is still far away from being used for mass production. This is primary due to two main reasons.

- Firstly, SCFE isolates only non-polar compounds, which are oil-soluble
- secondly due to very high installation costs of these units.

It is estimated that an industrial unit would require a capital outlay of around 10 Cr. for installing a unit of commercially viable capacity i.e. 3 cylinders of 50 ltrs capacity each. Due to this very high marginal cost of investment, this technique is currently being used only by large industrial units and still require more modification for making in available for general production.

SCFE extraction system includes extraction of natural products such as spice oil & oleoresins, flavours, fragrances, colours, decaffeination of tea & coffee, production of uniform & ultra-fine particles, supercritical CO2 textile dyeing of fabrics, supercritical CO2 cleaning of high precision metal compounds, drying of aerogels. Supercritical fluid extraction systems enable longer shelf life of extracts, high potency of active components, high flexibility of process conditions, simultaneous fractionation of extracts, low batch times for extraction, recycling of CO2 and a low operating cost.

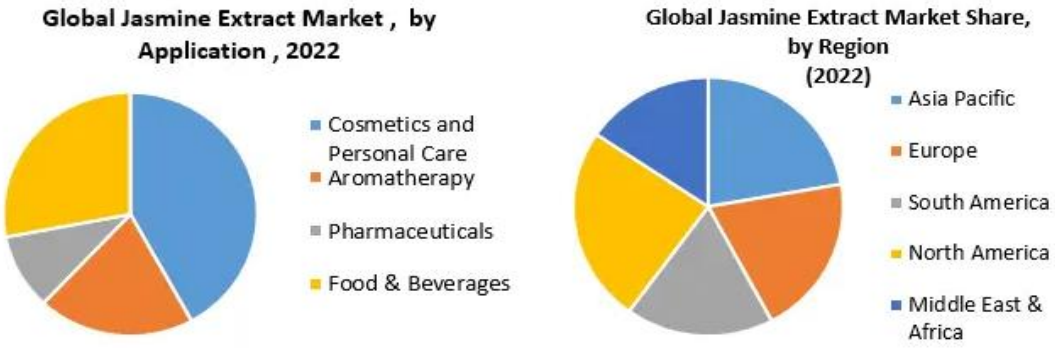
- **List of major suppliers/ manufacturers of SCFE units and availability of SCFE facility is mentioned under Appendix – I and II respectively.**

Market presence & estimation

With the introduction of advanced technology, the traditional fragrance industry has seen a vast variation in recent years along with offering innumerable opportunities for new entrants to grow in the market. Global fragrance & flavour industry is worth $24.10 Billion and India contributes approximately $500 million.

Global Market of Jasmine:

In the global market of jasmine extract production, as per year 2022, North America leads with 22% global market share of jasmine extract production followed by Asia Pacific 20%.



- In 2022, the global market for jasmine extract was valued at US$ 77.4 million. It is projected to grow at a Compound Annual Growth Rate (CAGR) of 9.8% from 2022 to 2032. By the end of 2032, it is expected to reach US$ 196.2 million.
- In the end-use category, the cosmetic & personal care segment holds the largest value share, representing approximately 39.6% with a value of US$ 30.6 million in 2022. This segment is forecasted to grow at a CAGR of 9.4% during the forecast period.
- Regarding extraction methods, the Supercritical fluid extraction (SCFE) segment currently holds a value market share of 33.5%, amounting to approximately US$ 25.9 million in 2022. It is expected to reach around US$ 66.5 million by the end of 2032.

Economic value

Jasmine cultivation has significant economic value globally, particularly in India highlighting its contributions to employment, poverty eradication, and rural development. The jasmine extract industry is booming as jasmine extract is in high demand in personal care, cosmetics and food & beverage industries. Jasmine, presently is being used for its medicinal value for use

as antidepressant, antiseptic, antispasmodic, Aphrodisiac, and sedative. Also, components of jasmine flower like indole, has varied applications in pathophysiological conditions such as cancer, microbial and viral infections, inflammation, depression, migraine, emesis, hypertension. Due to its appealing aroma and probable health advantages, the jasmine extract is being used in perfumes, lotions, soaps, candles, and massage oils

The market's expansion is ascribed to the expanding scope of aromatherapy, nutraceuticals and cosmetic products.

Few value-added products of jasmine:

1. **Jasmine Essential Oil**: Jasmine essential oil is extracted from the flowers and used in aromatherapy, perfumery, and cosmetics. Its sweet, exotic fragrance makes it a highly sought-after ingredient in luxury perfumes and skincare products.
2. **Jasmine Extract for Food and Beverages:** Jasmine extract derived from the flowers can be used in the production of various food and beverage products to add a unique floral note. It can be used in desserts, confectionery, and specialty beverages.
3. **Jasmine Scented Products:** Jasmine flowers are used to infuse scents into a variety of products, including candles, incense, air fresheners, and potpourri. These products help create a pleasant and calming environment in homes, spas, and other spaces.
4. **Jasmine Plant-Based Natural Pesticides:** Jasmine plants have natural insect-repellent properties, which can be utilised in the production of environmentally friendly pesticides.
5. **Jasmine Decorative Products:** Dried jasmine flowers can be used in the production of decorative items such as potpourri, floral arrangements, and handmade crafts.
6. **Jasmine-Based Natural Cosmetics:** Jasmine extracts are used in the formulation of natural and organic cosmetics, including face masks, moisturisers, and hair care products. These products are known for their soothing and rejuvenating properties.
7. **Jasmine-based Health and Wellness Products:** Jasmine flowers and plant extracts are incorporated into health and wellness products, such as herbal supplements, aromatherapy oils, and natural remedies, for their potential stress-relieving and calming effects.
8. **Jasmine-based Natural Dyes:** Jasmine flowers can be used as a natural source of dye in the textile industry, providing a sustainable and eco-friendly alternative to synthetic dyes.

9. **Jasmine Plant for Landscaping:** Jasmine plants are commonly used in landscaping due to their attractive foliage and aromatic flowers, adding beauty and fragrance to gardens, parks, and outdoor spaces.

Market profile of Jasmine in Udupi and Mangalore regions:

The annual production of Udupi Mallige is 863.55 tonnes and its value is estimated at ₹ 120 crore. As per the crop survey carried out by the department, there are 1,300 jasmine growers in the district. However, according to the Udupi Mallige Belagarara sangha, there are about 10,000 jasmine growers. Due to the dwindling production of jasmine, the price of the fragrant flower goes up to Rs 800- Rs 1,000 per 'atte'. In local parlance, one 'atte' of jasmine comprises four chendus. One chendu on average has 800 buds of jasmine woven together.

Table 1: Cost of Udupi mallige (in rupees)

	Quantity (Atte per day)	**Rate/ Atte (Rs)**	**Total Value (Rs)**
Yield (no. of atte)			
Summer season	750	300/-	2,25,000/-
Rainy season	100	500/-	50,000/-
Winter season	140	500/-	70,000/-
Gross returns	**3,45,000/-**		
Net returns	**1,75,579**		
Profit per atte (Rs.)	**177.35/-**		

Table 2: Cost incurred and returns by wholesalers of Udupi mallige per atte
*Note: One atte consists of four chendu and each chendu consists of 800 flowers.

Season	Particulars	Value (Rs.)
Rainy and winter season	Labour	22.50
	Fuel charges including depreciation of motor vehicle to collect chende from farmers	5.00
	Banana leaves to pack atte	0.60
	Stringing material	0.80
	Total marketing cost	28.90
	Commission	20.00
	Rent seeking	25.00
	Total marketing margin	45.00
	Profit	16.10
Summer season	Labour	2.75
	Fuel charges including depreciation of motor vehicle to collect chendu from farmers	0.50
	Banana leaves to pack atte	0.16
	Stringing material	0.23
	Total cost	3.64
	Commission	10.00
	Rent seeking	7.50
	Total returns	17.50
	Profit	13.86

Table 3: Annual transaction of wholesalers and retailers of Udupi mallige

Particulars	Qty transacted per day in atte	Cost incurred per season (Rs.)	Returns realized per season (Rs.)
Wholesalers			
Rainy & winter season	20	140454	218700
Summer season	200	88816	427000
Retailers			
Rainy & winter season	3	20210	72900
Summer season	25	35036	107625

Table 4: Price spread in marketing of Udupi Mallige (Rs./Atte)

Particulars	Summer	Rainy	Winter
Price received by the producer	300	500	500
Cost incurred by the wholesaler	3.64	28.9	28.9
Marketing margin of wholesaler	17.5	45	45
Cost incurred by the retailer	9.82	20.73	20.73
Marketing margin of the retailer	25.18	79.27	79.27
Price paid by the consumer (Retail price)	356.14	673.9	673.9
Total price spread	56.14	173.9	173.9
Producer Share in Consumer Rupee (%)	84.27	74.19	74.19

Estimation of Jasmine in Mangalore – Distribution Channel, Business to Business and Business to Consumers obtained from Major dealers:

Majority of the jasmine in Mangalore are sold to vendors for distribution channel for conventional use. On day to day basis each wholesale dealers sells about 150 Atte of Udupi Mallige and 100 Attes of Bhatkal Mallige. Mangaluru mallige is seasonal and is directly sold by cultivators in the market. The deman for jasmine in Mangaluru market is for conventional use rather than industrial or frangrance market due to the demand and supply gap.

(*Information as obtained by whole sale dealers: AR Flowers, Mission street Mangalore, Carstreet Flower Market, HMB Jasmine Jaj, Hampankatta, UM Ummar, K S Rao Road)*

Problems faced by jasmine cultivators

The problems faced are divided into three categories namely, production constraints, technological constraints and marketing constraints

Production constraints

- **Labour intensive harvesting**

  Jasmine flowers are delicate and often need to be hand-picked, which can be a labour-intensive process. The availability of skilled labour during peak harvesting periods can be a challenge for jasmine cultivators.

- **Pest and disease infestations:**

  Jasmine plants are susceptible to various pests such as bud worm, red spider mite, and blossom midge, diseases such as leaf blight, wilt nematode and root rot. These infestations can reduce plant health and flower quality.

- **Resource availability**

  Access to resources such as improved varieties of jasmine, suitable land for cultivation and proper irrigation facility can vary, and lack of resources can hinder jasmine cultivation efforts. On-time availability, price and quality of necessities such as chemicals, fertilisers, composts, insecticides and fungicides play a major role in productive cultivation of jasmine. Lack of adequate loan facility for the cultivators is also observed.

Technological constraints

Lack of knowledge about proper planting and nursery management of jasmine is a technological constraint widely observed. Scientific management of crops and timely updating of new technology available in the market is a necessity.

People in rural areas mostly do not have access or are unable to operate the improvised part of technology, including the mobile application, and are left behind in the process.

Marketing constraints

- Time constraint & high commission charges: In cut flower segments, consumers prefer buds rather than fully bloomed flowers. Since this flower is highly perishable, care should be taken to deliver the jasmine buds to consumers before it blooms into flower in a very short period of time. Cultivators are levied high commission charges by immediate market functionaries i.e., contractors, wholesalers, and commission agents for transportation and selling of flowers at appropriate time.
- Cultivators also face lack of infrastructure, poor accessibility and low frequency of transportation in rural areas.
- Fluctuation in price of jasmine and exorbitant higher charges are the major issues in jasmine cultivation.

Jasmine fragrances

Jasmine fragrances are those fragrances that have a high concentration of jasmine. Jasmine extracts are comparatively gentle and soft than the sultry heady jasmine absolutes with rich aroma. The growth of the market is attributed to the increasing end use demand in the food and beverage, personal care, and cosmetics sector.

Market Segmentation:

- **By Type:** Methyl Dihydrojasmonate, Methyl Jasmonate, Jasmone and others
- **By Application:** Cosmetics, Soap And Detergent, Perfume, Aromatheraphy and others

Indole is one of the constituents of perfumery importance present in buds. It is highly volatile. Fully opened, freshly collected flowers during early morning hours are used for extraction. On average, the essential oil recovery ranges from 0.24 to 0.42% and the concrete yield is about 22 kg (49 lb) per hectare. Further on processing the concrete yields absolute to the extent of about 50% of the concrete production.

Raw Materials Requirement: The main raw materials required for the business of oil extraction from jasmine flowers include:

- Jasmine Flower
- Solvents (if using solvent extraction) such as hexane
- Packaging materials such as bottles or jars

Data Analytics:

$$\text{Percentage of absolute oil (on petal basis)} = \frac{\text{Weight of absolute oil}}{\text{Weight of petals}} \times 100$$

$$\text{Percentage of absolute oil (on concrete oil basis)} = \frac{\text{Weight of absolute oil}}{\text{Weight of concrete}} \times 100$$

Details of Jasmine yield extract from *Jasminum sambac*

Details of jasmine concrete oil and absolute oil recovered from two different stages of flower harvested one at closed bud stage and from fully open flowers using the supercritical fluid extraction method

Per kg of *Jasminum sambac* can yield:

	Fresh Blossom/ Ton of flower	Dry Blossom/ Ton of flower
Concrete	1.5 – 2.5 Kg	2.5 – 3.2 Kg
Absolute	0.6- 1.2 Kg	1.2 – 1.8 Kg

Total annual production and Revenue generation: (w.r.t Udupi region)

Total jasmine collection per day = 950 Jasmine Chendu (4 chendu = 1 Atte)

Total jasmine collection per Month = 950 Jasmine Chendu×20 days

= 19000 Chendu

Total ton of production per Month = 19000 Jasmine Chendu ×50gms = 1 Ton

Total production annually = 1 Ton ×8 months = 8 Tons

Jasmine off seasons: December, January, July and August, hence 8 months

Range of absolute or concrete jasmine that can be produced

	Per month (1 Ton)	Per year (8 Tons)
Concrete oil	1.5 – 2.5 Kg	12-20 Kg
Absolute oil	0.6- 1.2 Kg	4.8 – 9.6 Kg

Price Range:

	Price (Rs/Kg)
Concrete oil	0.45 - 1 lakhs
Absolute oil	1.5- 3 lakhs

Product characteristics and specification

Jasmine concrete

Appearance	Wax like substance
Composition	Contains natural perfumes, plant waxes,albuminous and colouring matters.
Appearance:	Waxy, Solid
Colour	Yellowish brown
Odour	Characteristics flowery odour
Specific gravity	0.8796 (0.886-0.898) at 55 degree
Refractive index	1.468 at 50 deg.At 60 deg. (1.464-1.4658)

Jasmine Absolute

Appearance	Viscous oily liquid
Preparation	Absolute is prepared by removing the insoluble wax from the concrete
Colour	Dark brown
Odour.	Odour reminiscent of fresh flowers
Specific gravity	0.9508 at 30 degree 0.929-0.955 at 60 degree
Refractive index	1.4882 at 30 deg. (1.4822 to 1.4935 at 20 deg.)

- **Details of key players in Jasmine extract (by region) and manufactures is mentioned in Appendix – III**

Acquiring the Necessary Equipment and Machinery:

- Harvesting equipment such as hand-held picking baskets
- Distillation equipment (if using steam distillation)
- Solvent extraction equipment (if using solvent extraction) such as a mixer, centrifuge, and filtration system
- Filtering equipment
- Laboratory equipment such as gas chromatography and mass spectrometry machines
- Packaging equipment such as bottles or jars
- Filling machines and labelling machines

Ensuring Compliance with Regulatory Requirements:

The specific requirements will vary depending on the location of the business and product type. Some of the most common Regulatory Requirements include:

- Business registration
- Food and Drug Administration (FDA)
- Essential oil quality certification from ISO (International Organization for Standardization) or the National Association for Holistic Aromatherapy (NAHA)
- Health and safety certifications such as an OSHA (Occupational Safety and Health Administration) certification
- Environmental permits

Key Challenges and Risks Associated in the Business

- Fluctuating flower supply and crop failure
- Quality control,
- Competition and market demand
- Oil quality issues
- Price volatility

Market Potential and Marketing strategies:

- Jasmine oil has a wide range of applications – Conventional and value-added product development
- Wide businesses niche - cosmetic, fragrance, wellness industries

APPENDIX – I

List of major suppliers/ manufacturers of SCFE units

Extraction unit	Manufacturer	Specifications	Estimated price /Piece
Supercritical CO_2 fluid extraction system, Grade standard: Food grade	Chemtron Science Laboratories, Navi Mumbai. Mahape, Navi Mumbai, Dist. Thane	**Extraction Method:** CO_2 GAS **Grade Standard:** Food Grade **Usage/Application:** Essential oils **Cylinder Size:** 5 LTR TO 75 LTR **Installation Services:** Yes	₹ 20,90,500/-
Supercritical Fluid Extraction Plant	Shritara Engg & Project Consultants Malad West, Mumbai	**Capacity:** 0.5 litre to 5000 litre **Nano Particles Deposition on Cloth:** Textile Dyeing **Non-Polar Organic Extraction:** Mineral and Metals deposition **Oleo Resin:** Ginger Turmeric Nutmeg Clove Vanilla **Installation Services:** Yes	₹ 25,00,000/-

Supercritical CO_2 Fluid Extraction System	Chemtron Science Laboratories Private Limited Thane	**Material:** Essential oil extraction **Automation Grade:** Semi-Automatic **Product Type:** Lab , Research & Industrial **Country of Origin**: Made in India	₹ 19,20,300/-
Supercritical Fluid Extraction Plant	Ram Krishna Engineering Works Vadodara	**Automation Grade:** Automatic **Frequency:** 50-60Hz **Material:** SS 316 **Phase:** 3 Phase **Power Source:** Electric **Voltage:** 220-440V	₹ 40,00,000/-
Carbon Dioxide CO_2 Extraction Plant	Shourya Supercritical Technology Tehsil- Shirala, Sangli	**Technique**: Using Carbon dioxide **Extraction Method:** Supercritical Fluid Extraction Technology **Extractor Capacity:** 25 Litre **Number of Extractors:** 3 **Country of Origin:** Made in India	₹ 60,00,000/-

Supercritical Fluid Extraction Plant SCFE (10 liter onward)	Akshit Instruments Private Limited Laxminagar , New Delhi, New Delhi	**Technique:** Supercritical Fluid Extraction with Liq. CO_2 **Capacity:** starting from 10 liters, upto 1000 liters. **Extraction Method:** Supercritical Fluid Extraction with Liq. CO_2 **Material:** process vessel & Separator material will be SS 316 only	₹ 80,00,000/-
Lab, research & Industrial Supercritical Co2 Fluid Extraction System	Chemtron Science Laboratories Private Limited Mahape, Navi Mumbai, Dist. Thane	**Model Name/Number:** Supercritical CO_2 Fluid Extraction System **Usage/Application:** Essential oil extraction **Product Type:** Lab , Research & Industrial **Automation Grade:** Semi-Automatic	₹ 19,20,300/-

APPENDIX – II

Availability of SCFE facility

1. **Nisarga Biotech Pvt. Ltd.**

Company Background and Operations:

- It is the first Indian company who has developed SCFE technology totally indigenously and the products (natural extracts, herbal extracts etc.) manufactured at their plant have been recognized at international level.
- Has Supercritical fluid extraction (SCFE) plant design and manufacturing capability, experience of running and operating SCFE plant and exports Supercritical Extracted oils and extracts to the USA, Agriculture inputs to Greece, Spain and France.

Products/ Services:

- Supercritical extracted essential oils, herbal extracts
- Spice oils and extracts Black Pepper Oil, Cardamom Oil, Cinnamon Bark oil, Clove Bud Oil, Coriander seed oil, Cumin seed oil ,Ginger oil, Nutmeg oil
- Perfumery: Ambrette seed oil, Sandalwood oil, Patchouli oil, Bakul Extract Champaka Extract , Davana Cyperus Root Oil
- Herbal products : Indian Valerian oil, Neem Leaf Extract, Spikenard oil Extract, Turmeric Extract Oil
- SuperCritical Extraction plant and technology for extraction

Contact Details

- Shri P V Shinde - Director
- Address: Nisarga Biotech Pvt. Ltd. 275, Chandan Nagar ,M.I.D.C., Satara- 415004
- E-mail: krushitek@vsnl.com
- Mobile: 9552794004

2. **Sami-Sabinsa Group**

Company Background and Operations:

- Manufactures and markets Phytonutrients and standardized herbal extracts, specialty fine chemicals, and organic intermediates used in the nutritional, pharmaceutical and food industries.

- Provides custom manufacturing from lab scale to pilot / semi-commercial scale, and process development. The company selects ingredients with a long history of traditional success and conducts clinical research to confirm their efficacy.
- Industry and Academia collaboration to develop commercially ready products

Products/ Services:

- Super Critical Fluid Extracts
- Phytonutrients and standardized herbal extracts

Contact Details:

- **Address:** 19/1 & 19/2I Main, II Phase, Peenya Industrial Area, Bangalore India
- **E-mail**: info@sami-sabinsagroup.com
- **Number:** +91 80 6852 7777, +91 80 2839 7974

3. **National Institute of Pharmaceutical Education and Research, S.A.S. Nagar**

Background and Operations:

- Extraction of natural products/herbals. Natural Products Field Laboratory, Department of Natural Products, at the institute is equipped with following two SCFE systems
- SCFE Lab Scale and Pilot Scale

Products/ Services:

- Charges: Lab scale- Rs. 4000/- per sample or per hour of instrument time + service tax Pilot scale Rs. 8000/- per sample or per hour of instrument time + service tax
- Government academic institutes/other institutes or universities/non-profit making government-sponsored institutes will be charged half of the charges indicated above.

- SME-Pharma will be charged half of the charges indicated above. The samples need to be processed through SME-centre, SMPIC, Block-G, NIPER.

Contact Details:

- **Address:** Head, Department of Natural Products, NIPER-SAS Nagar, Punjab.
- **Email:** smpic@niper.ac.in
- **Number:** 0172-2292036, 2292037

4. IIT – Bombay

Background and Operations:

- Study of a large variety of specific systems requiring SCF processing, development of process and engineering designs of SCF systems (bench top to commercial scale) for SCF-based extraction of natural products (spices, medicinal herbs, natural colours, flavours and fragrances, etc.) and SCF-based micronization of nutraceuticals and pharmaceuticals Technology Consultation
- Consulting assignments for the industry is typically executed in five consecutive phases

Products/ Services:

- Process optimization
- Selection/choice of viable products
- Selection of optimum plant configuration
- Troubleshooting and re-engineering of existing SCFE plants

All meetings with IIT Bombay SCF-research faculty group may only be by appointment, set up through either email communication or telephonic discussion.

Financial Charges:

- Each phase of work for an industrial client is assessed separately for arriving at the total charges for its execution. This typically includes the institutional overheads (based on the extent of use of research facilities) and faculty consultation fees. The minimum consultation charge is Rs 10,000/-.

Contact details:

- The Principal R&D Team Members from IIT Bombay are faculty with the Department of Chemical Engineering
- Prof Sandip Roy - sr@che.iitb.ac.in
- Prof Madhu Vinjamur - madhu@che.iitb.ac.in
- Prof Mamata Mukhopadhyay - mm@che.iitb.ac.in 8)
- **Group email:** scfe@che.iitb.ac.in
- **Contact Number:** 022-25764236

APPENDIX – III

Details of key players in Jasmine extract (by region) and manufactures:

Jasmine Extract Market, by Region

- North America (United States, Canada and Mexico)
- Europe (UK, France, Germany, Italy, Spain, Sweden, Austria and Rest of Europe)
- Asia Pacific (China, South Korea, Japan, India, Australia, Indonesia, Malaysia, Vietnam, Taiwan, Bangladesh, Pakistan and Rest of APAC)
- Middle East and Africa (South Africa, GCC, Egypt, Nigeria and Rest of ME&A)
- South America (Brazil, Argentina Rest of South America)

Key players in the Global Jasmine Extract Market

North America:

- Ultra International Ltd.
- Vigon International Inc.
- Berje Inc.
- Phoenix Aromas & Essential Oils LLC
- Essential Ingredients
- Penta International Corporation

Europe:

- Albert Vieille SAS
- Ernesto Ventos SA
- Nactis Flavours
- Elixens France SAS
- Jean Niel SAS
- Mane SA

Asia-Pacific:

- Kanta Group
- Shanghai Pu-Jie Fragrance Co., Ltd.
- PT. Indesso Aroma
- Quinessence Aromatherapy Ltd.
- Jiaxing Sunlong Industrial & Trading Co., Ltd.
- Gulab Singh Johrimal

Latin America:

- Fábrica de Aromas S.A.
- Aroma Chemical Services International SAS
- Indukern Fragrance Division
- Lucta S.A.
- Agronatura Brasil
- Scentec Indústria e Comércio de Fragrâncias Ltda.

Middle East:

- El-Khalil Fragrances
- Mane Egypt S.A.E.
- Al Haramain Perfumes
- Rasasi Perfumes Industry LLC
- Swiss Arabian Perfume Group
- Abdul Samad Al Qurashi