Aromatic Plants Cultivation, Processing And Uses
<table>
<thead>
<tr>
<th>Code:</th>
<th>ENI120</th>
</tr>
</thead>
<tbody>
<tr>
<td>Format:</td>
<td>Paperback</td>
</tr>
<tr>
<td>Indian Price:</td>
<td>975</td>
</tr>
<tr>
<td>US Price:</td>
<td>100</td>
</tr>
<tr>
<td>Pages:</td>
<td>504</td>
</tr>
<tr>
<td>ISBN:</td>
<td>8178330571</td>
</tr>
<tr>
<td>Publisher:</td>
<td>Pacific Business Press Inc. Asia</td>
</tr>
</tbody>
</table>
Aromatic plants have essential or aromatic oils naturally occurring in them. They help heal mental ailments and other diseases. India is endowed with a rich wealth of medicinal plants. Aromatic (Aroma Producing) plants are those plants which produce a certain type of aroma. Their aroma is due to the presence of some kind of essential oil with chemical constituents that contain at least one benzene ring in the their chemical configuration. The chemical nature of these aromatic substances may be due to a variety of complex chemical compounds. These plants have made a good contribution to the development of ancient Indian material medica. In recent years, there has been a tremendous growth of interest in plant based drugs, pharmaceuticals, perfumery products, cosmetics and aroma compounds used in food flavors and fragrances and natural colors in the world. There is a definite trend to adopt plant based products due to the cumulative derogatory effects resulting from the use of antibiotic and synthetics and except for a few cultivated crops, the availability of plant based material is mainly from the natural sources like forests and wastelands. There is a need to introduce these crops into the cropping system of the country, which, besides meeting the demands of the industry, will also help to maintain the standards on quality, potency and chemical composition. During the past decade, demand for aromatic plants and its products has attracted the worldwide interest, India being the treasure house of biodiversity, accounts for thousands of species which are used in herbal drugs. 90% of herbal industry requirement of raw material is taken out from the forests.

Some fundamentals of this book are botanical description of the plant, genetic improvement , harvesting, intercropping, transplantation, irrigation and weeding, vanilla cultivation in india, commercial cultivation of vanilla, distillation of herbage for essential oil, effect of growth hormones, jasmine crop improvement & agrotechniques, efforts for new vatiety of jasminum auriculatum , essential oils of agarwood, cinnamomum tamala leaves, eucalyptus citriodora and caultheria pragrantissima, past and future of sandal wood oil industry, by product development from turmeric and ginger rhizomes, isolation of essential oils and its flavour profile etc.

This book contains most of the important aspects related to aromatic plants. It is being published for those who are interested in growing, processing and trading of aromatic plants.

**Tags**

Aromatic plants cultivation India, Cultivation of aromatic plants, Aromatic plants farming, Cultivation of aromatic crops, List of aromatic plants in India, Names of aromatic plants, Aromatic plants, Processing of Aromatic Plants, Extraction of essential oils from aromatic plants, Extraction of essential oils by steam distillation, Essential oil extraction methods, How Are Essential Oils Extracted?, Essential oils, Extraction of Volatile Oil from Aromatic Plants, Steam distillation procedure, How to extract plant oils by distillation?, How to extract oil from plants?, List of aromatic plants and their uses, List of Important Aromatic Plants, Multiple Uses of Aromatic Plants, Commercial cultivation of aromatic plants

**Content:**
1. Cultivation of Tagetes Minuta
   Botanical description of the plant
   Genetic improvement
   Agrotechnology
   Soil and climate
   Propagation
   Weed control
   Fertilizers and manures
   Irrigation
   Harvesting
   Intercropping
   Crop rotations
   Diseases
   Distillation
   Chemistry
   Distillation unit design availability

2. Cultivation of Eucalyptus Citriodora
   Description of the plant
   Cultivation
   Soil and Climate
   Preparation of Land
   Propagation
   Nursery
   Transplanting
   Weeding
   Manures and Fertilizers
   Harvesting
   Pests and Diseases
   Distillation
   Yield
   Chemical Constituents
   Uses

3. Cultivation of Rosmarinus Officinalis
   Introduction
   Description of the plant
   Cultivation
   Soil and Climate
   Propagation
   Transplanting, interculture and fertilizer application
   Irrigation
   Harvesting
   Pests and diseases and their control
   Distillation
4. Cultivation of Coriander Sativum
Description of the Plant
Cultivation
Soil and Climate
Propagation
Irrigation
Harvesting
Pests and Diseases
Distillation
Yield
Chemical Constituents
Uses
Economics of Cultivation

5. Cultivation of Lavender Species
Botany
Soil and Climate
Cultivation
Propagation
Propagation By Seeds
Transplantation
Fertilizer Application
Weeding
Regeneration
Harvesting
Distillation
Oil Content and Oil Yield
Chemical Constituents
Uses
Economics of Cultivation

6. Cultivation of Matricaria Chamomilla
Description of the Plant
Genetics
Cultivation
Soil and climate
Propagation/nursery
Transplantation, irrigation and weeding
Cropping sequence
Pests and diseases
Manures and fertilizers
Harvesting
Collection of seeds
Yield
Drying and storage
Distillation
Yield and characteristics of the oil
Uses
Specification of the drug
Economics of cultivation

7. Vanilla  World’s second most expensive spice
Vanilla Flower
Vanilla Beans
Vanilla cultivation in India
Commercial Cultivation of Vanilla
Vanilla Extract and Flavourings
Commercial uses of Vanilla
Market for Vanilla
Exports grades and standards

8. Cultivation of Artemisia Annua
Description of the plant
Soil and climate
Propagation
Weed control
Fertilizers and manures
Irrigation
Harvesting
Chemistry and uses
Distillation
Economics of cultivation

9. Cultivation of Mentha Arvensis
Plant descriptors
Available cultivars of menthol mint
Choice of place for cultivation
Land preparation
Preparation of planting material
Production of suckers
Production of seedlings
Planting of suckers in the field
Fertilizer application
Irrigation and drainage
Interculture and weed control
Crop rotation
Intercropping
Harvesting
Yield
Storage of herbage
Insect pests
Diseases
Distillation of herbage for essential oil
Directly fired distillation tank
Design availability
Use of mint oil and its derivatives
Economics of cultivation

10. Cultivation of French Basil (Ocimum Bacilicum L.)
1. European Type
2. Reunion Type
3. Methyl Cinnamate Type
4. Eugenol Type

Botany
Soil and Climate
Field preparation
Propagation
(a) Raising of Nursery
(b) Planting
Irrigation
Fertiliser Application
Interculture
Harvesting and Yield
Agronomical Studies
Physiological Studies
Heavy metal tolerance
Effect of growth hormones
Mineral contents
Seed mucilage studies
Effect of photoperiodism
Biosynthesis of Eugenol
Tissue Culture Studies
Genetical Studies
Chemical Composition
Uses
Cosmetic
Food
Folk medicine
Ayurvedic Properties

11. Jasmine Crop improvement & agrotechniques
New varieties of jasmine
Arka Surabhi
Arka Arpan
Efforts for new variety of Jasminum auriculatum
for extraction of essential oil
Constituent of Jasmine essential oil
Agronomy
Plant protection
Water saving, labour saving low cost device for
propagation of plant cuttings
Details of the device
Required materials for the device
Detailed method
Economic viability of growing jasmine for essential oil

Introduction
Chemistry of Nuts

13. Himalayan Cedarwood Oil
Essential oil of Deodar (Cedrus Deodara)
Essential oil of Juniperus Recurva var. Squamata and
other oils of Juniperus spp.
Agarwood and Oil Agarwood
Uses

14. Essential oils of Agarwood, Cinnamomum Tamala Leaves,
Eucalyptus Citriodora and Caultheria Pragtantissima
Distillation
Gaultheria
Eucalyptus

15. Past and Future of Sandal wood Oil Industry
Plantation and Harvesting
Disease Control
Distillation of Oil
Packing
Problems and their Solutions
Adulteration
Future Prospects
Kewda Industry in Orissa

16. Production Technology and Package of Practices in Chilli
Cultivated Species of Capsicum
Constraints in Chilli Production
Technologies Developed
Disease and Disease Management
Marketing in Chilli
17. By Product Development from Turmeric and Ginger Rhizomes

Introduction
By Product Development in Turmeric
Curcumin
Turmeric Essential Oils
Isolation of Essential Oils and its Flavour Profile
By product Development in Ginger
Survey of Raw Material
Essential oils
Oleoresin
Gingerol in Ginger Oleoresin
Starch
Protein
Crude Fibre
Commercial Extraction of Ginger Oleoresin
Process Description for Oleoresins
Oleoresin Quality
Flavour Quality of Ginger Oleoresins
Essential Oils of Ginger
Profile of Flavour in Ginger Cultivars

18. Synthesis of 4 Acetyl 3, 7, 7 trimethylbicyclo [4, 1, 0] hept 3 ene and Related Compounds by Friedel Crafts Reaction on (+) Car 3 ene

Results and Discussions
1. Synthesis of 4 acetyl 3, 7, 7 trimethylbicyclo [4, 1, 0] hept 3 ene and its position isomers (II).

Experimental
Fractionation of Turpentine Oil for Isolation of 3, 7, 7 trimethylbicyclo [4, 1, 0] hept 3 ene (I).
4 Acetyl 3, 7, 7 trimethylbicyclo [4, 1, 0] hept 3 ene and its position isomers (II).
Separation of IIa, and IIc by Column Chromatography.
4 Acetyl 3, 7, 7 trimethylbicyclo [4, 1, 0] hept 2 ene (IIb)
3 Methylene 4 acetyl 7, 7 dimethylbicyclo [4, 1, 0] heptane (IIc)
4 Propionyl 3, 7, 7 trimethylbicyclo [4, 1, 0] hept 3 ene and position isomers (III).
Separation of IIIa, IIIb and IIIc by column Chromatography.
4 Propionyl 3, 7, 7 trimethylbicyclo [4, 1, 0] 
    hept 3 ene (IIIa).
4 Propionyl 3, 7, 7 trimethylbicyclo [4, 1, 0] 
    hept 2 ene (IIIb).
3 Methylene 4 propionyl 7, 7 dimethylbicyclo [4, 1, 0] 
    heptane (IIIc).
4 Butyryl 3, 7, 7 trimethylbicyclo [4, 1, 0] 
    hept 3 ene and its position isomers (IV).
Sederation of IVa, IVb and IVc by column chromatography.
4 Butyryl 3, 7, 7 trimethylbicyclo [4, 1, 0] hept 3 ene (IVa).
4 Butyryl 3, 7, 7 trimethylbicyclo [4, 1, 0] hept 2 ene (IVb).
3 Methylene 4 Butyryl 7, 7 dimethylbicyclo [4, 1, 0] 
    heptane (IVc).

19. Free and Glycosidically bound 
    volatiles of Clove (Eugenia caryophyllata)
Experimental Procedures
Capillary Gas Chromatographic Analysis
Results

20. Cultivation of Spices
Black Pepper
Climate
Soil
Varieties
Production of Rooted Cuttings
Cultural Practices
Standards
Planting
Under Planting
Soil Fertility and Nutrient Management
Irrigation
Bush Pepper
Diseases
Pests
Harvesting
Cardamom
Mainfield Planting
Varieties
Propagation
Diseases
Pests
Cloves
Climate and Soil
Varieties
Planting Material
Planting
Manuring
Diseases
Pests
Nutmeg
Cultural Practices
Manuring
Pests
Cinnamon
Cultural Practices
Diseases
Manuring and Processing
Diseases
Pests

Ginger
Varieties
Cultural Practices
Diseases
Pests
Turmeric
Varieties
Cultural Practices
Diseases
Pests

21. Bunium persicum (Boiss.) Fedtsch
   Botany, Conservation Strategies and Cultivation
Botanical Description of Plant
Climate and Distribution
Reasons and Remedies for Dwindling Population of B. persicum in Nature
Phenotypic Variability
Climate
Soil Type
Preparation of Land
Plantation
(i) Plantation Through Seeds
(ii) Plantation Through Tuberous Roots
Spacing
Method of Plantation
Manuring
Weeding
Irrigation
Harvesting
Intercropping
Pests and Diseases of Kala Zira Crop
Experimental Studies for the Propagation of Planting Material Under Laboratory Conditions
Regeneration Through Tissue Culture
Economics of the Crop
Conclusion

22. Essential Oils of Artemisia species in Kashmir Himalaya
Artemisia moorcroftiana Wall
Artemisia laciniata Wild
Artemisia salsoloides Will
Artemisia persica Boiss
Artemisia vestita Wall
Conclusion

23. Cultivation and Utilization of Kaempferia galanga L.
Botany
Crop Improvement
Crop Management
Extraction of Essential Oil
Physico chemical Properties of Oil
Utilisation

24. Cultivation and Improvement of Sweet Marjoram
Floristics and Crop Improvement
(i) Floristics
(ii) Studies on Floral Biology
(iii) Crop Improvement
Crop Production and Management.
(a) Soil and Climate
(b) Propagation
(c) Studies on Nutrient and Spacing
(d) Use of Growth Regulators
(e) Crop Rotation/Sequencing and Inter crops
(f) Irrigation and Inter culture
(g) Insect Pests and Diseases
(h) Harvesting, Production of Essential Oil and Yield
(i) Chemistry of Oil

25. Cultivation of Davana for Essential Oil
Introduction
Botany
Floral biology
Climate
Soil
Nursery raising
Transplanting
Manures and fertilizers
Irrigation
Interculture
Growth regulator application
Plant protection
Insect pests
Diseases
Harvesting
Distillation
Yield and Oil content
Chemical Constituents
Physico chemical characteristics of davana

26. Essential Oil of Hyptis Suaveolens Poit
   Antimicrobial Efficacy of the Essential Oil of H. suaveolens
   (ii) Phytotoxic Behaviour of the Oil
   (iii) Chemical Constituents of the Oil
   Conclusions

27. Tagetes minuta (Wild Marigold)
   An Economic Crop for Hilly Regions
   Introduction
   Crop Management
   Harvesting and Distillation
   Quality Evaluation
   Uses of Tagetes Oil
   Research Needs

28. Present Status of Jamrosa - A Review
   Cultivation
   Areas Under Cultivation and Marketing Prospects

29. Cultural Practices of CKP 25
   (Lemongrass) under Irrigated conditions
   Introduction
   Effect of Date of Plantings
   Effect of Different Spacing Combinations
   Effect of Nitrogen Levels
   Recommendations

30. Development of New Cultivars of Cymbopogons as
    Source of Terpene Chemicals

31. Indian Cymbopogons Botany, Agrotechnology,
    Utilization, Constraints and Future Scope
Botany
Morphology
Taxonomic Position
Distribution
Cytological Studies
*Chromosome Number
*Cytogenetics
*Reproduction
Agrotechnology
Age of Plantation
Manures and Fertilizers
Irrigation
Weed Control
Harvesting
Genetic Improvement
Utilization
Essential Oils
Major Research and Development Constraints
Conclusion and Scope for Future Work
32. Growth and Performance of Cymbopogon citratus Stapf., the West Indian Lemongrass and Cymbopogon pendulus (Nees ex Steud.) Wats., the Jammu Lemongrass in West Bengal
Result and Discussion
Intraspecific Variation:
Interspecific Variation:

33. Indian Turpentine Oil as a Raw Material for Terpene Chemicals
Production of Oil of Turpentine
Utilization of Oil of Turpentine
 Constituents of Oil of Turpentine and their Derivatives

34. Cultivation of Musk Mallow in Jammu
Introduction

35. Morpho Economic Features of Burma Citronella (Cymbopogon winterianus Jowitt)
Introduction
Discussion

36. Oxidation of Y Terpinene and Isolongifolene with t Butyl chromate
 Oxidation of terpinene (I)
 Oxidation of isolongifolene (VI)

37. Scope for Commercial Cultivation of Aromatic
Plants in Upper Pulney Hills

Sample Chapter:
Cultivation of French Basil
(Ocimum Bacilicum L.)
About 60 Ocimum species are found to grow in tropical Asia, Africa, America and subtropical regions of the world, from sea level to an altitude of about 1800 m. Of these, Ocimum bacilicum Linn. Is considered the most important for its Sweet Basil Oil. It is known to have been cultivated for at least three thousand years by Europeans and Asians for folklore and religious rituals and got established wherever they migrated with extreme variation of its progeny. However, owing to a high degree of polymorphism exhibited by the species, as also abundant cross-pollination, a large number of sub-species, varieties and forms or strains have come into existence which make the botanical nomenclature extremely difficult. Thus, several names have been assigned to the same varieties and even to some of the lesser understood varieties and forms of other species. The genetical studies conducted to account for the difference in the compisition of oils have indicated that the differences are not specific. This is due to the presence or absence of certain genes which control the biogenetic pathway at a particular stage of oil synthesis. In view of the great diversity, the various species and varieties have been classified, in accordance with their chemical composition and geographical source, into 4 major types as under:

Ocimum Bacilicum
1. European Type
The main constituents in the oil are methyl chavicol and linalool, but no camphor. This group comprises French and American Sweet Basil Oils which are laevorotatory in nature and are very much in demand in the trade because of high quality and the finest odour.
2. Reunion Type
The main constituents of the oil are methyl chavicol and camphor, but no linalool. This group comprises oils distilled in Reunion Island, Comoros, Madagascar and the Seychelles which are dextrorotatory and of somewhat lower quality.

3. Methyl Cinnamate Type
Whereas methyl chavicol and linalool form the principal constituents of this oil, methyl cinnamate is present in substantial amounts. The oils distilled in Egypt, Sicily, Bulgaria, erstwhile British East India and Haiti come under this group, which are laevorotatory.

4. Eugenol Type
The principal constituent of the oil is eugenol. This group comprises oils distilled in Java, Seychelles, Samoa and U.S.S.R., which are dextrorotatory.

Nine species are recorded from India, of which three are exotic. The more important of these species are:

1. Ocimum bacilicum Linn. (Eng. - French or Sweet Basil, Hindi -Babui Tulsi). it has the following sub-species and varieties:
   1. Ocimum basilicum Linn. subsp. minimum Danert (Syn. O. Minimum Linn.)
   2. Ocimum basilicum var. majus Benth.
   3. Ocimum basilicum var. difforme Benth. (curly-leafed Basil)
   4. Ocimum basilicum var. purpurascens Benth. (Violetred Basil)
   5. Ocimum basilicum var. glabratum Benth. (Common white Basil)
   6. Ocimum basilicum var. pilosum Benth. (Syn. O. pilosum Roxb.)
   7. Ocimum americanum Linn. (Syn. O. canum Sims)(Eng.-Hoary Basil, Hindi-Kala Tulsi)
   8. Ocimum gratissimum Linn. (Eng.-shrubby Basil, Hindi-Ban or Ram Tulsi)
   10. Ocimum sanctum Linn. (Eng.-Sacred or Holy Basil, Hindi-Tulsi)
   11. Ocimum viride Willd. (Eng.-Fever Plant of Sierra Leone)

Of the above species, Ocimum basilicum Linn. alone is cultivated in India on a commercial scale. The oil of sweet basil owes its importance to its extensive use in condimentary products, cosmetic, toiletry, perfumery and confectionery industries, particularly in European countries.

Botany
Ocimum basilicum Linn. occurring in nature as a tetraploid (2n=48) belongs to the family Labiatae. It is an erect, almost glabrous herb, reaching a height of 30-90 cm and cultivated in major parts of the country. The plant has many oil glands which impart it a characteristic aromatic odour. Leaves ovate-lanceolate, 3.75-5 cm long; entire or dentate, adaxial and abaxial surfaces glabrous, glandular; petioles very slender, usually slightly hairy; flowers 0.72-1.25 cm long, borne in long terminal raemose inflorescences, simple or much branched, often thyrsoid, bracts stalked, ovate, minute, caducous; calyx 5-toothed, upper tooth rounded, shorter than others, 2 lower teeth ovate-lanceolate with a bristle point, 2 lateral shorter than the lower, calyx partly grown together with bracts, enlarges itself postflorally and remains with the latter dry on plant; corolla 0.72-1.25 cm long, white, pink or pale-purplish, 2-lipped, tube short, upper lip nearly equally 4-lobed, lower lip curved down, not lobed; stamens 4, protruding, twice as long as corolla, bent, hairy at bend; ovary bicarpellary, syncarpous, bilocular, becoming tetralocular later; stigma bifid; fruits nutlets, 4, ellipsoid, dark brown to nearly black, oblong with rounded ends, minutely dotted, convex on one side and flattened on the other, surface pitted, varying in size from 2.0-2.9 mm in length by 1.2-1.9 mm in width, mucilaginous covering from heavy to scant, swell in water within 10 minutes with no further swelling after 3 hours.

Soil and Climate
The plant thrives best on moderately fertile but well drained loamy or sandy-loam soils. The clavey or sandy soils are unsuitable for its cultivation. The best soils are those which are in good physical condition and have good water holding capacity. The waterlogged lands must invariably be avoided.
The plant is rather susceptible to frost and the crop growth is adversely affected in areas which experience heavy and continuous rainfall. In the hilly areas of north India, therefore, it is advisable to raise it as a Kharif crop. In the plains of north India or south India and Assam, it could, however, be grown both as Kharif and Rabi crops. In areas with a heavy rainfall, the crop could be raised provided the plants get well established prior to the break of monsoon and the rain water does not stagnate in the field.

Field preparation
The field in which the crop is to be raised should be disc ploughed once (if necessary), follwed by two crosses harrowings and one planking. The operations may be so directed that the land is ready for planting in north Indian plains in May-June or October-November and in hills by the end of March or latest by the last week of April. The soil need not be prepared to a fine tilth but any stubbles of the previous crop should be removed. Convenient sized beds, which may be 15 m x 15 m, are laid out with proper provision for irrigation as well as interculture operations.

Propagation
The crop is raised through seeds, but direct sowing of seeds in the field is not advised. The usual practice is to raise the seedlings in the nursery first and then transplant them in the field.

(a) Raising of Nursery
The location of nursery should ensure adequate irrigation facilities. The land must be cleared of stubbles, weeds, etc. and soil worked well up to 30 cm in depth. Well rotted farmyard manure and leafmould each, at the rate of 1 kg per sq m, is applied and the soil is very well pulverised so as not to leave any clods.
Convenient sized beds of 1 m x 4 m, with irrigation channel systems, are laid out. The small size of nursery beds facilitates removal of weeds without entering the beds. As the seeds are minute, they must invariably be mixed with fine sand or wood-ash to ensure even distribution in the seedbeds. Seed rate per bed of size 1 m x 4 m should be 10-15 g. Since 1000 seeds weigh a little over 1 g and the germination percentage is 90-95, about 125 g seeds are required to give sufficient seedlings for transplanting in 1 hectare.

The seeds may be sown in lines, about 6 cm apart, or broadcast over the beds and covered with thin layer of sand and farmyard manure. Care should however, be taken to avoid deep sowing which adversely affects the germination. In the plains of north India, sowing should be done either in the months of April-May or August-September and in the hilly regions in April. The germination of seeds starts 3 days after sowing and it is practically over in about 10 days. It is advisable to cover the seedbeds lightly with straw so as to conserve moisture, which may be removed when the seedlings emerge. In dry months, it may be necessary to water seedlings twice a day. The nursery must be kept clear of the weeds. The seedlings, when 6-10 cm tall, are carefully dug up for transplanting in the field.

(b) Planting
The field, at the time of planting, should have good tilth. If the transplanting is to be done in dry months, the seedlings should invariably be covered with moist gunny cloth, hessian or green leaves, soon after their removal from the nursery. This is necessary to protect them from strong sun especially on bright sunny days. The transplanting in such conditions must be done towards the evening and the field irrigated liberally thereafter. Cloudy weather and fine drizzle are considered ideal for transplanting.

It is recommended to transplant the seedlings 40 cm apart, in rows, 60 cm apart.

Irrigation
When raised as a Kharif crop, irrigation is required once every week. With the onset of monsoon, the rains meet the water requirements of the crop fully till September. Thereafter, irrigation may be required once or twice a month.

Fertiliser Application
In order to raise a good crop, adequate supply of nutrients is essential. It is advisable to apply 20 kg N, 40 kg P2O5 and 40 K2O per hectare, as basal dose, before planting. 40 kg of Nitrogen should also be applied as top dressing in two equal split doses.

Interculture
The first weeding to the crop should be given about one month after planting, at the time when the seedlings are established well in the field. The second weeding-cum-hoeing may be necessary after another 4 weeks and thereafter; the plants become bushy thereby suppressing the weeds. Earthing of the plants is preferable. Expenditure on weeding may be considerably minimised in large plantations through the use of cultivator drawn by tractor.

Harvesting and Yield
The crop is harvested when the plant is in full bloom and lower leaves tend to turn yellowish. Harvesting can be done with the help of hand sickles. Depending upon a number of factors, the crop may come to full bloom 8-12 weeks after planting in different regions of the country. Corresponding to the part harvested, that is to say, flowers or the whole herb, two grades of oil are obtained. The oil produced from flowers alone has a superior note and fetches a higher price in the trade. In order to obtain high quality of oil, it is advisable to harvest only the flowering tops.

In tarai regions, optimum yield of herb has been obtained by harvesting first four crops consisting of main as well as sub-inflorescences alone and the last crop of the whole herb. Of these four floral harvests, the first is taken when the plants are in full bloom and the second as well as the subsequent harvests after every 15-20 days thereafter. For the last harvest, the plant as a whole is cut close to the ground. In Assam
(Jorhat), three harvests only are taken and the whole plant is harvested. The first harvest takes place 12
weeks after planting and two more at an interval of two months each. It is estimated that 3-4 floral harvests
mentioned above give about 3-4 tonnes of flowers and the final harvest of the whole plant about 13-14
tones of herbage per hectare. Under certain situations, such as the shortage of labour, instead of flowers,
the whole herb may have to be harvested, 3-4 times, at an interval of 1 month each from the first harvest. In
that event, about 18-20 tonnes of herbage is obtained per hectare. While harvesting first and subsequent
crops of the whole herb, utmost care must be exercised to cut the individual plants not less than 15 cm from
the ground so that effective regeneration of the crop takes place. If the plants are cut too close to the
ground, they may die altogether or produce rather poor second crop.

On an average, whereas the young inflorescences contain about 0.4 per cent oil, the whole herb
containonly 0.10 to 0.25 per cent (Table-1). In actual practice, a yield of about 30-35 kg of oil per hectare,
corresponding to 12-13 kg of flower oil and 18-22 kg of whole herb oil is obtained. If only whole herb is
harvested and distilled, the yield of oil per hectare may be about 30 kg.

After the crop is harvested, it is advisable to allow it to wilt in the field for 4-5 hours so as to reduce the
moisture in the herb. This helps reducing the herbage somewhat in bulk and facilitates its easy packing in
distillation tubs. The herbage should however, not be exposed to sun for prolonged drying as it adversely
affects the quality of oil. It may be pointed out here that both the yield of herb and percentage of oil
contained therein may vary greatly depending directly upon the fertility of soil as well as seasonal
conditions. Further, the more bushy types of plants with not too many large stems yield more oil for the
simple reason that oil resides chiefly in the flowers and leaves. Also, bright sunny weather immediately
preceding the harvest increases the oil while cloudy or rainy weather decreases it.

Distillation

The oil of sweet basil is obtained on distillation of young inflorescences and/or whole herb by both hydro-
distillation and steam distillation. The latter is considered definitely better than the former in that it takes less
time and effects better recovery of oil contained in herb. While the former carried on in a direct fire still is
cheaper and more handy for small plantations, the latter is preferred for large plantations.

In steam distillation, the equipment consists of a boiler, a distillation vat or tub, a condenser and 1-3
operators. The steam is generated in the boiler that led through a steam inlet pipe under a pressure of 18-
32 kg into the distillation tub filled with the charge to be distilled. Through an outlet pipe, the other vapours
along with the essential oil contained in the herb, pass over to the condenser. As the distillation proceeds,
the distillate goes on collecting in the operator.

The oil being lighter than water and insoluble is floats on the surface and is periodically drawn off, then
decanted and filtered to get rid of impurities. About 1-1½ hours are required to exhaust a charge
completely. It is necessary that the distillate should be warm as it comes out of the condenser. After the oil
has been separated from the distillation water, it is advisable to re-distill the latter to recover small count of
oil held in suspension. This may be done to separate distillation tub or in the same tub after main charge
has been distilled. It is most important that the distillation equipment must be clean before the distillation is
started, otherwise the quality of the oil is affected imparting it a disagreeable odour or sometimes-
undesirable colour.

Agronomical Studies

The reported life zone of sweet basil is 7 to 27 degrees centigrade, with 0.6 to 4.2 meters annual rainfall
and a soil pH of 4.3 to 8.2. The crop which is susceptible to frost and cold-temperature injury, develops best
in full sun and well-drained loamy or sandy-loam soils. In the hilly areas of the north India, it is advisable to
raise it as a kharif crop. In the plains of north India or South India and Assam, it could however, be grown
both as a kharif and rabi crops. In areas with heavy rainfall, the crop could be raised before the onset of
monsoon.
### Table 1

**Physicochemical Properties of Oil of Sweet Basil**

*(Ocimum bacilicum Linn.)* Produced in Different Places

<table>
<thead>
<tr>
<th>Sl.No.</th>
<th>Properties</th>
<th>Jammu Whole herb oil</th>
<th>Tarai of Naini Tal Flower oil</th>
<th>Uttar Pradesh Herb oil</th>
<th>Assam Whole herb oil</th>
<th>France Flower oil</th>
<th>America Whole herb oil</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Yield of oil %</td>
<td>0.5 - 0.66</td>
<td>0.22 - 0.55</td>
<td>0.10 - 0.28</td>
<td>-</td>
<td>0.09 - 0.11</td>
<td>-</td>
</tr>
<tr>
<td>2.</td>
<td>Specific gravity</td>
<td>0.9016 (20°C)</td>
<td>0.8792 - 0.9198 (18°C)</td>
<td>0.8886 - 0.9288 (18°C)</td>
<td>0.9183 (29°C)</td>
<td>0.8959 - 0.9168 (15°C)</td>
<td>0.9132 - 0.9278 (15°C)</td>
</tr>
<tr>
<td>3.</td>
<td>Refractive index</td>
<td>1.4892 (20°C)</td>
<td>1.4582 - 1.4718 (17°C)</td>
<td>1.4662 - 1.4757 (17°C)</td>
<td>1.4798 (29°C)</td>
<td>1.4770 - 1.4880 (20°C)</td>
<td>1.4883 - 1.4943 (15°C)</td>
</tr>
<tr>
<td>4.</td>
<td>Optical rotation</td>
<td>- 10°7'</td>
<td>- 6°36' to - 9°36'</td>
<td>- 4°0' to - 7°0'</td>
<td>- 9°0'</td>
<td>-10°14' to - 6°21' to</td>
<td>- 9°42'</td>
</tr>
<tr>
<td>5.</td>
<td>Ester value</td>
<td>1.2</td>
<td>4.73 - 6.86</td>
<td>4.60 - 17.10</td>
<td>7.20</td>
<td>3.50 - 9.80</td>
<td>-</td>
</tr>
<tr>
<td>6.</td>
<td>Alcohols (calc. as linalool)</td>
<td>48.5%</td>
<td>57.60 - 60.10%</td>
<td>41.10 - 50.00%</td>
<td>54.70%</td>
<td>34.50 - 39.66%</td>
<td>-</td>
</tr>
<tr>
<td>7.</td>
<td>Methyl chavicol content</td>
<td>-</td>
<td>25.30 - 29.00%</td>
<td>35.20 - 40.50%</td>
<td>33.90%</td>
<td>55.00%</td>
<td>-</td>
</tr>
</tbody>
</table>

Cultivation practices of this crop in different parts of India have been studied. The crop is raised through seeds. Seeds are required @ 125 g/ha for raising nursery. 6-10 cm tall seedlings are transplanted in field and 40 cm x 60 cm of spacing is recommended for the plants. Fertilizers @ 20 kg N, 40 kg P2O5 and 40 kg K2O/ha are given as basal dose before planting. Two equal split doses of N @ 40 kg is applied as top dressing. Waheb et al (1983) reported 68-84% increase in herbage yield when NPK was applied @ 120,100,100 kg/ha, respectively. Singh et al (1987) studied the response of various doses of nitrogen to the crop. He reported that optimum nitrogen rates of 146.1, 120.2 and 128.2 kg/ha yielded essential oil @ 61.6, 54.6 and 56.6 kg/ha, respectively.

Irrigation is required once a week, when it is grown as a summer crop. Otherwise once or twice a month irrigation is found to be sufficient.

Depending upon the environment, sweet basil is harvested 2-5 times annually and grown as an annual or short-lived perennial. The first harvest is initiated just prior to open bloom of the white or purplish flower that appear in summer, 10-16 weeks after planting. As the quality of the product associated with colour and aroma retention is strongly influenced by post-harvest handling, leaves and flowering tops are dried at low temperatures to retain maximum colour before guiding to marketable size or distilling for essential oil. Floral harvests yield about 3-4 tonnes of flowers and the final harvest of the whole plant is about 13-14
tonnes of herbage per hectare. Putievsky have studied different harvesting schedules for basil in Israel. He has also studied influence of high frequency of harvest and the date of the first harvest on plant growth. Higher yields were obtained from later phenological stages. It was observed that higher yield of herbage and oil was recorded when harvesting was done between early seeding to late seeding stage of growth at Delhi conditions.

Losses of NH₃, P & K with run off waters were insignificant when tobacco was rotation with sweet basil in comparison to growing it as a monoculture.

Physiological Studies

Heavy metal tolerance

Veeranjaneyulu studied heavy metal tolerance in basil. Ocimum bacilicum was found to be tolerant to higher concentrations of copper and zinc and is susceptible to copper and nickel. They also studied intrachloroplast localization of Zn and Ni in Ocimum bacilicum in order to investigate the mechanism and specificity of metal tolerance. It was observed that Zn activity was comparatively greater in chloroplast envelop membranes and stroma than the Ni. Ni was largely found in the lamellar and stroma fraction. Analysis of lamellar fraction revealed that photosystem II particles were richer in radioactivity than photosystem I particles. The photochemical events of photosynthesis were less affected in Zn-treated plants than in the Ni-treated plants.

Effect of growth hormones

Ahmed studied the effect of gibberellic acid and cycocel on the growth and essential oil content of Ocimum bacilicum. Gibberellic and @ 50, 100 and 200 ppm decreased the weight of plants, especially that of leaves in a concentration dependent manner.

Mineral contents

Gasparyan investigated the mineral contents of basil under open hydroponic conditions. The mineral content of vegetable parts decreased in Order K] Ca] Mg] P] S]Fe. Basil had the higher P contents. The yield of hydroponically cultivated herb plants was 3-10 fold that of soil culture and contains 3-10 folds as much mineral elements as the latter did.

Seed mucilage studies

Tharanathan investigated the polysaccharides from the seed mucilage of Ocimum bacilicum. D-glucose, D-galactose, D-mannose, L-arabinose, D-xylose, D-rhamnose and D-galacturonic and D-mannuronic acids were isolated. The mucilage was partly O-acylated and contained lipids and studied the disintegrative properties of the O. bacilicum mucilage. The seed powder of O. bacilicum has a superior disintegrating property for pharmaceuticals as compared to those of M-cellulase, starch and isabgol.

Effect of photoperiodism

It was observed the effect of photoperiodism on the growth and essential oil of O. bacilicum. Flower development was most rapid when exposed to 18 h of light daily. The optimum yield in herb was obtained under 24 h of light, for photoperiods of 15 to 18 h, the yield was slightly lower but the plants reached harvesting stage 10 days earlier.

Biosynthesis of Eugenol

Mannito showed through labelling experiments that eugenol was biosynthesized from L-phenylalanine by loss of the carboxylic C atom at the ferulic acid level and introduction of extra C without skeletol re-arrangements. Methyl eugenol estragole and chavicol were biosynthesized similarly. Phenylalanine, cinnamic acid and ferulic acid were intermediates in the biosynthesis of eugenol. Mannito further observed incorporation of specifically labelled cinnamic acid into eugenol. The results were interpreted on the basis of a new biogenetic hypothesis.

Tissue Culture Studies

Lange studied production accumulation of essential oil in Ocimum bacilicum cell cultures. In
morphologically differentiated callus and suspension cultures, both free monoterpenoids and 
phenylpropanoid components and their glycosides were found. They further observed that essential oil 
formation is apparently not related to the place of accumulation. The principal glycoside components were 
linalool, borneol, eugenol and thymol glycosides and considerable amount of monoterpenoid glucosides. 
Clonal propagation of Ocimum species has been studied. Apical nodal segments of Ocimum were cultured 
in revised MS medium supplemented with cytokinins, auxins individually and in combinations. The 
developed plantlets were transferred to field with 10-25% mortality. Uniform increase in shoot number from 
a single explant was observed during subculturing it at optimum conditions up to 40-45 days with an initial 
lag of 15-20 days, after which shoot number remained the same.
Dalton studied chlorophyll production and photosynthetic development in fedbatch cultures of Ocimum 
basilicum. Sweet basil cell suspension were cultured in the glucose limiting conditions of fedbatch cultures 
and the glucoseexcess conditions of batch cultures. When compared, the cells in fedbatch culture had a 
higher specific production rate of total chlorophyll and a higher potential photosynthetic rate. Results from 
these and other fedbatch cultures indicated that total chlorophyll did not change much with specific growth 
rate. Thus, the inhibition of total chlorophyll at high glucose feed rates was not thought to be caused directly 
by the increase in specific growth rate.
Photosynthetic development of O. basilicum on transition from phosphate to fructose limitation has also 
been studied. Phosphate in MS medium was found to be limiting growth; when PO4 concentration in the 
medium feed was doubled, the concentration of dry biomass and of all biomass elements increased. After 
doubling the phosphate concentration, fructose became limiting. O. basilicum cells responded to the 
transition from phosphate limitation to fructose limitation by becoming greener and more photosynthetic; 
consequently the yield on fructose increased. Production rate of chlorophyll was inhibited when glucose 
concentration in the cell was above or threshold of about 1.2% dry biomass. The degree of inhibition was a 
function of glucose concentration above this threshold.
Genetical Studies
Cytological studies of Ocimum sp. has been done by many authors. Two basic chromosome number x=8 
and x=12 has been reported. The species belonging to Basilicum group has x=12 chromosomes. 
The floral structure of Ocimum species is most suitable for pollination by insects, particulary by bee. There 
is a strong tendency in the species to outbreed within the population. The frequency of intravarietal hybrids 
varied from 5.8% to 18.5% in O. basilicum. Krishnan recorded outcrossing upto 66.7% in the experiments 
and emphasized the need for growing varieties in isolation to ensure varietal purity. They have also studied 
inheritance of field reaction to Cercospora disease. It was found that field reaction was oligogenically 
controlled and possibly by a single gene with the dominant allele conforming field resistance. In O. 
basilicum, the most commonly operating mechanism against cross breeding between the different varieties 
is geographical isolation. Sobti did extensive hybridization experiments. The failure of formation of hybrids 
in interspecific crosses was due to differences in floral structure of the species physiological factors and 
genetic factors. The reciprocal crosses in these are successful. 
The elucidation of genetics of pigmentation in seedling and adult plant parts in this crop has provided a 
valuable gene marker in seedling pigmentation for such studies.
Inheritance of chemical constituents of essential oils in O. basilicum was studied. They showed that citral, 
linalool, geraniol, which are monoterpenes are inherited independently of methyl chavicol and eugenol 
which are phenolic in nature. Three chemical races rich in (1) camphor, (2) eugenol and (3) methyl chavicol 
have been isolated from O. basilicum var. glabratum. Presence and absence of these constituents is 
controlled by a single gene which exists in three allelic responsible for the formation of methyl chavicol. Any 
of the two recessive alleles can be present in the plant in addition to the dominant gene but is not able to 
express it. Thus, no eugenol or camphor is formed in the plants having gene for methyl chavicol. They have
further showed that gene responsible for citral is dominant over geraniol and linalool. But the gene responsible for the formation of methyl cinnamate blocks formation of citral, geraniol, linalool and methyl chavicol and eugenol.

Kundu while studying interspecific variation in the amount of DNA in Ocimum L., showed that the diploid chromosome number and 4C nuclear DNA content of Ocimum species have no linear relationship.

Chemical Composition

The volatile oil contains d-linalool and methyl chavicol as the major components; with the former up to 55% and the latter about 70%, depending on the sources. Other components include methyl cinnamate, which has been reported to be the major component of a variety of sweet basil, 1,8-cineole, eugenol, borneol, ocimene, geraniol, anethole, 10-cadinols, b-carophyllene, a-terpineol, camphor, 3-octanone, methy Eugenol, safrole, sesquithujene and 1-epicycloinesquiphellandrene among others. The percentage of major chemical constituents differ in oil obtained from different parts of the plant viz., flower, herb, diseased plants, etc., as evident from Table-4.

Table-1

<table>
<thead>
<tr>
<th>Diseases/Pests</th>
<th>Causal Organism</th>
<th>Symptoms</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blight</td>
<td>Corynospora cassicola (Berk. &amp; Curt.) Wie</td>
<td>Brown Coloured spots</td>
<td>-</td>
</tr>
<tr>
<td>Alternaria Sp.</td>
<td>Chlorotic spots</td>
<td>Dithane Z-78</td>
<td></td>
</tr>
<tr>
<td>Leaf Blight</td>
<td>Colletotrichum capsici(Sy.) Butler &amp; Bisby</td>
<td>- do -</td>
<td>-</td>
</tr>
<tr>
<td>Wilt</td>
<td>Fusarium oxysporum</td>
<td>Whole plant</td>
<td>Tafason Agalol</td>
</tr>
<tr>
<td>Scab</td>
<td>Elsinoe arxii sp. nov.</td>
<td>Defoliation</td>
<td>-</td>
</tr>
<tr>
<td>Rhizosphere</td>
<td>Aspergillus candidus</td>
<td>-</td>
<td>Agrimycin</td>
</tr>
<tr>
<td>Mycoflora</td>
<td>Penicillium humicola</td>
<td>Phytomycin</td>
<td></td>
</tr>
<tr>
<td>Humicola sp.</td>
<td>Dithane M- 45</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Myrothecium sp.</td>
<td>Thiran</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alternaria tenuis</td>
<td>(Major ones among total of 33 reported)</td>
<td>[td]</td>
<td>Pests</td>
</tr>
<tr>
<td>Leaf rollers</td>
<td>Defoliation</td>
<td>Malathion Thiodon</td>
<td></td>
</tr>
<tr>
<td>-------------</td>
<td>-------------</td>
<td>-------------------</td>
<td></td>
</tr>
<tr>
<td>Tingid bug</td>
<td>Cochlochila bullita (Stal) Horvath</td>
<td>Defoliation</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Pycharmon caberalis Guen.</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

There are great variations in concentrations of these components in the volatile oils from different sources. A comparative study of chemical composition of French, Italian and Moraccan basil oil was made. The results are tabulated in Table-2.

The results of the comparative quantitative studies on the chemical constituents of commercial basil oils of South Africa, France, Comoro Island & Egypt is given in Table-3. It is very clear from these comparative studies that the chemical composition and morphological characteristics of O. bacilicum are highly variable, depending largely upon the source. The basil oil of Chinese origin was also investigated. The major compounds identified were methyl chavicol, linalool, 1,8-cineole, ocimene, linalyl acetate, eugenol, menthone, cyclohexanol, cyclohexanone, nerol and myrcenol. Other constituents present in sweet basil include protein (14%), carbohydrates (61%), and relatively high concentrations of vitamins A and C.

Table-2

<table>
<thead>
<tr>
<th>Chemical Constituents of French, Italian and Moraccan Basil Oil</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constituent</td>
</tr>
<tr>
<td>-------------</td>
</tr>
<tr>
<td>a- Pinene</td>
</tr>
<tr>
<td>b- Pinene</td>
</tr>
</tbody>
</table>
Myrcene
0.16
0.18
0.68

Car-3-ene
0.06
0.07
0.33

a-Terpinene
t
t
0.03

Limonene
0.12
0.20
0.26

1,8-Cineole + cis-Ocimene
2.70
3.40
8.10

a-Terpinene + 3-Octanone +

trans-Ocimene
0.46
0.70
<table>
<thead>
<tr>
<th>Compound</th>
<th>Concentration</th>
</tr>
</thead>
<tbody>
<tr>
<td>p-Cymene</td>
<td>1.90</td>
</tr>
<tr>
<td>Terpinolene</td>
<td>0.07</td>
</tr>
<tr>
<td>cis-allo-Ocimene</td>
<td>0.22</td>
</tr>
<tr>
<td>cis-3-Hexenol</td>
<td>0.05</td>
</tr>
<tr>
<td>Menthone</td>
<td>0.40</td>
</tr>
<tr>
<td>Fenchyl acetate</td>
<td>0.07</td>
</tr>
<tr>
<td>Copaene + b-bourbonene</td>
<td>0.54</td>
</tr>
<tr>
<td>Compound</td>
<td>Value 1</td>
</tr>
<tr>
<td>--------------------------</td>
<td>---------</td>
</tr>
<tr>
<td>Linalool</td>
<td>0.83</td>
</tr>
<tr>
<td>Fenchyl alcohol + Bisabolene + Isocaryophyllene + β-elemene</td>
<td>9.20</td>
</tr>
<tr>
<td>Caryophyllene + Terpinen - 4-ol</td>
<td>1.00</td>
</tr>
<tr>
<td>Menthol</td>
<td>0.27</td>
</tr>
<tr>
<td>Methyl chavicol</td>
<td>23.20</td>
</tr>
<tr>
<td>β-Terpineol</td>
<td>0.90</td>
</tr>
<tr>
<td></td>
<td>Percentage</td>
</tr>
<tr>
<td>----------------</td>
<td>------------</td>
</tr>
<tr>
<td>a - Terpinyl acetate</td>
<td>2.50</td>
</tr>
<tr>
<td></td>
<td>6.30</td>
</tr>
<tr>
<td></td>
<td>2.18</td>
</tr>
<tr>
<td></td>
<td>3.80</td>
</tr>
<tr>
<td>Citronellol</td>
<td>2.80</td>
</tr>
<tr>
<td></td>
<td>1.63</td>
</tr>
<tr>
<td></td>
<td>1.90</td>
</tr>
<tr>
<td>Geraniol</td>
<td>0.05</td>
</tr>
<tr>
<td></td>
<td>0.39</td>
</tr>
<tr>
<td></td>
<td>0.28</td>
</tr>
<tr>
<td>Methyl Eugenol</td>
<td>0.80</td>
</tr>
<tr>
<td></td>
<td>0.49</td>
</tr>
<tr>
<td></td>
<td>0.07</td>
</tr>
<tr>
<td>Methyl cinnamate</td>
<td>0.50</td>
</tr>
<tr>
<td></td>
<td>0.16</td>
</tr>
<tr>
<td>Eugenol</td>
<td>6.60</td>
</tr>
<tr>
<td></td>
<td>3.40</td>
</tr>
<tr>
<td></td>
<td>19.20</td>
</tr>
</tbody>
</table>

Table-3
Chemical Composition of Basil Oils of Different Origins
<table>
<thead>
<tr>
<th>Constituent</th>
<th>South Africa</th>
<th>Comoro Island</th>
<th>France</th>
<th>Egypt</th>
</tr>
</thead>
<tbody>
<tr>
<td>a - Pinene</td>
<td>0.30</td>
<td>0.18</td>
<td>0.11</td>
<td>0.25</td>
</tr>
<tr>
<td>Camphene</td>
<td>0.07</td>
<td>0.06</td>
<td>0.02</td>
<td>0.07</td>
</tr>
<tr>
<td>b - Pinene</td>
<td>0.38</td>
<td>0.25</td>
<td>0.07</td>
<td>0.43</td>
</tr>
<tr>
<td>Myrcene</td>
<td>0.32</td>
<td>0.12</td>
<td>0.13</td>
<td>0.35</td>
</tr>
<tr>
<td>Limonene</td>
<td>4.94</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Compound</td>
<td>Value 1</td>
<td>Value 2</td>
<td>Value 3</td>
<td>Value 4</td>
</tr>
<tr>
<td>-------------------</td>
<td>---------</td>
<td>---------</td>
<td>---------</td>
<td>---------</td>
</tr>
<tr>
<td>Cis - ocimene</td>
<td>0.11</td>
<td>2.52</td>
<td>0.03</td>
<td>0.63</td>
</tr>
<tr>
<td>p - Cymene</td>
<td>0.06</td>
<td>0.05</td>
<td>0.10</td>
<td></td>
</tr>
<tr>
<td>Cis-3-hexenol</td>
<td>0.02</td>
<td>0.06</td>
<td>0.08</td>
<td></td>
</tr>
<tr>
<td>Fenchyl acetate</td>
<td>0.11</td>
<td>0.20</td>
<td>0.55</td>
<td>0.09</td>
</tr>
<tr>
<td>Camphor</td>
<td>0.75</td>
<td>0.37</td>
<td>1.43</td>
<td></td>
</tr>
<tr>
<td>Compound</td>
<td>Value 1</td>
<td>Value 2</td>
<td>Value 3</td>
<td>Value 4</td>
</tr>
<tr>
<td>---------------------</td>
<td>---------</td>
<td>---------</td>
<td>---------</td>
<td>---------</td>
</tr>
<tr>
<td>Linalool</td>
<td>0.57</td>
<td>54.37</td>
<td>1.16</td>
<td>40.72</td>
</tr>
<tr>
<td>Fenchyl alcohol</td>
<td>6.29</td>
<td>1.20</td>
<td>6.70</td>
<td>5.52</td>
</tr>
<tr>
<td>Methyl chavicol</td>
<td>2.38</td>
<td>85.75</td>
<td>23.79</td>
<td>26.56</td>
</tr>
<tr>
<td>α - Terpiniol</td>
<td>0.83</td>
<td>0.84</td>
<td>1.90</td>
<td>1.09</td>
</tr>
<tr>
<td>Citronellol</td>
<td>2.77</td>
<td>0.65</td>
<td>3.57</td>
<td>1.76</td>
</tr>
<tr>
<td>Geraniol</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Methyl cinnamate
0.34
0.05
0.34
0.25
Eugenol
12.19
0.74
5.90
5.90

Pharmacology and Biological Activities
The volatile oil of a variety of sweet basil is shown to have an antibacterial and insecticidal properties. The oil has important medicinal properties. The study was prompted by the reported use of the fresh juice of this plant to treat a maggots-infested nasal disease in India. Sweet basil oil is reported to be nontoxic. Essential oil of O. bacilicum and O. sanctum is also reported to have insecticidal and larvicidal action. Antitubercular and antimalarial action of oil is also reported. Estragole (methyl chavicol), a major component in some sweet basil oils, has been shown to produce hepatocellular carcinomas in mice.

USES
Cosmetic
Sweet basil is used as a fragrance ingredient in perfumes, hair dressings, dental creams and mouth washes.
Food
Used as a spice and in chartreuse liqueur. The oil and oleoresin are extensively used as a flavor ingredient in all major food products, usually in rather low use levels (mostly below 0.005 ppm).

Table-5
Physico-chemical properties of sweet basil oil of Indian origin

<table>
<thead>
<tr>
<th>Properties</th>
<th>Jammu</th>
<th>Herb oil of Uttar Pradesh</th>
<th>Assam</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yield (%)</td>
<td>0.5 - 0.66</td>
<td>0.10 - 0.28</td>
<td>-</td>
</tr>
<tr>
<td>Sp.Gravity</td>
<td>0.9016 (20°C)</td>
<td>0.8896 - 0.9288 (17°C)</td>
<td>0.9183 (29°C)</td>
</tr>
</tbody>
</table>
Ref. Index | 1.4892 (20Â°C) | 1.4662 - 1.4757 (17Â°C) | 1.4798 (29Â°C)
---|---|---|---
Optical rotation | -10Â°7' | -4Â°0' to -7Â°0' | -9Â°C'
Ester value | 1.2 | 4.60 - 7.10 | 7.20
Alcohol (%) | 48.5 | 41.10 - 50.00 | 54.70
Methyl chavicol (%) | - | 35.20 - 40.50 | 54.70

Folk medicine
Used for head colds and as a cure for warts and worms among other ailments. It is more widely used as a medicinal herb in the Far East, especially in China and India. It was first described in a major Chinese herbal around 1060 A.D. and has since been used in China for spasms of the stomach and kidney ailments, among others; it is especially recommended for use before and after parturition to promote blood circulation. The whole herb is also used to treat snake and insect bites.

Ayurvedic Properties

Pharmacology : Antimicrobial activity of the essential oil has been shown against M. tuberculosis and Staph aureus in vitro and other bacteria and fungi. Eugenol and methyleugenol showed a positive activity. Adaptogenic (antistress) activity has been found in mice and rats. The plant increased the physical endurance and prevented stress-induced ulcers. In general pharmacology, the aqueous extract showed hypotensive activity and inhibited the smooth muscle contraction induced by acetylcholine, carbachol and histamine. It also potentiated the hexobarbitone sleeping time. Protective action against histamine-induced bronchospasm has been shown in animals.

Safety : The fresh leaves are taken as prasad by millions of Indians for many years. The powdered leaves, 5-27 g per day were taken by 120 patients for 3 months. The only side effect was constipation. In animals with large dose of an extract, antispermatogenic activity has been shown.

Clinical Usage : A tea prepared with the leaves of Tulsi is commonly used in cough, cold, mild indigestion, diminished appetite and malaise. The solid extract of Tulsi in a dose of 500 mg x 3 for one week, significantly relieved the breathlessness in 20 patients with tropical eosinophilia. There was however no reduction in the eosinophil count in peripheral blood. It is commonly used with black pepper in bronchial asthma. An oil extracted from Tulsi is used as drops in ear infections. Fungal and bacterial infections of skin are treated with Tulsi juice. The seeds are used as a general tonic.

Indications :
1. Common cold and cough.
2. Bronchospasm.
4. Skin infections, wounds.
5. Indigestion and nausea.

Formulations and Dosage:
- Fresh juice of leaves : 10-20 ml with honey b.i.d.
- Seed powder : 5-10 gms b.i.d.
- Tulsi oil : 2-3 drops in ear b.i.d.
Depending upon their geographical origin, a number of basil oils are offered for sale in the market. This is mainly because of the varying chemical composition of the oil. There are three main commercial types. The first is sweet basil oil, of which the principal constituents are cineole and d-linalool; the second is the Reunion-type basil oil, with cineole, d-camphor and methyl chavicol being the major constituent; the third, an intermediate type is comparatively rich in methyl cinnamate eugenol or thymol. All these types are distilled from varieties of the plant Ocimum basilicum. For the standpoint of production statistics, it is prudent to combine all the sources into one basil oil. As a consequence, the production of the year 1984 was summarised at about 14 metric tonnes with major producing countries being Comores contributing 6 tons, followed by Madagascar (2 tons), USA (1 ton), Albania (1 ton) and Egypt (1 ton). Undetermined quantities of oil were also produced in Pakistan, Italy, Yugoslavia, South Africa, Bulgaria, Reunion and Morocco.

The world production of different basil oil in 1986 stand at 12-14 tonnes. The world production of sweet basil was about 2 tonnes with Egypt accounting for nearly half of the production. Other principal producers of sweet basil being Yugoslavia, Morocco, Bulgaria, USA, Italy and Spain.

World production of Reunion-type oil is around 10-12 tonnes with Comoros, Madagascar and South Africa being the main producers. Production of intermediate type oil is wide spread, the main areas being Eastern Europe, Egypt, South South-East Asia and China. The exact production figures are not available.