

ESSENTIAL OILS

Sources of EOs

K. HÜSNÜ CAN BAŞER

www.khcbaser.com

khcbaser@gmail.com

kemalhusnucan.baser@neu.edu.tr

Sources of Essential Oils

- Aromatic plants can simply be described as those which emit fragrance.
- Such plants retain their fragrant chemicals in specialized tissues of the organs ever after drying.
- Therefore, they are used as a source of spices, condiments, food supplements, essential oils and aromatic extracts.
- Since the fragrant or aromatic chemicals that they biosynthesize also have biological activities they are also used as ingredients of botanicals.

Sources of Essential Oils

- Aromatic plants have been used as spices and condiments to make food more palatable and stable in storage due to antimicrobial and antioxidant properties of their volatile chemicals.
- Their active principles can be concentrated by distillation or extraction, and such products have been manufactured by flavour and fragrance industries and used in food, perfumery, cosmetics, pharmaceuticals and aromatherapy sectors.

Sources of Essential Oils

- Aromatic plant drugs including essential oils and natural aromachemicals have been used in the pharmaceutical industry as flavouring, and to mask the foul odour or taste of some pharmaceuticals as **excipients**.
- However, in recent years, many aromatic plant drugs are used as **active ingredients** of botanicals.

Sources of Essential Oils

- The most simple common traditional and modern use of aromatic plant drugs is as herbal tea.
- In many countries, pharmacies can freely dispense established tea formulations to patients for mild indications.
- In Germany, German Standard Licenses contain many herbal tea formulations with instructions to use.

Sources of Essential Oils

- Aromatic plants are the major source of essential oils which may be found in almost all parts of a plant such as leaves, flowers, bark, seeds, fruits, wood, rhizome, root, root bark, etc.

leaves (eucalyptus, cedar, laurel)
leafy branches (pine)
herbaceous parts (oregano, mint, sage)
flowers (rose, jasmin)
dried buds (cloves)
bark (cinnamon, cassia)
wood (sandalwood, cedarwood, rosewood)
bulb (onion, garlic)
roots (angelica, vetiver, orris)
rhizomes (ginger, orris)

fruits (aniseed, fennel, coriander, cumin)
fruit peel (orange, lemon)
pseudofruit (juniper)
seed (carrot seed, mustard seed, cardamom)
root bark (sassafras, xylophia)
balsam (storax, peru balsam)
oleogumresin (frankincense, myrrh, mastic)
oleoresin (turpentine, opopanax)
lichen (oakmoss, treemoss)

Sources of Essential Oils

- Among many others, main essential oil plant bearing families include **Apiaceae, Lamiaceae, Asteraceae, Cupressaceae, Lauraceae, Pinaceae, Rutaceae, Myrtaceae, Santalaceae, Zingiberaceae, Zygophyllaceae** etc.
- Essential oils, their fractions or aromachemicals isolated from them are ingredients of flavors and fragrances.

Collection and postharvest treatment

- In industrialized countries, medicinal and aromatic plants are mainly cultivated, however, in developing countries collection from wild sources is widespread.
- These supplies are generally exported to developed countries where they are utilized by the phytopharmaceutical and other industries.

Collection and postharvest treatment

- Indiscriminate collection of plant species has caused concern over a wide range of spheres and [WHO/IUCN/WWF](#) issued a joint guidelines on the conservation of medicinal plants in 1993.
- As a follow up to these measures, WHO issued another set of guidelines on good agricultural and collection practices for medicinal plants ([GACP](#)) in 2003.

Collection and postharvest treatment

- The first part of the guidance addresses to farmers and sets the rules for growing medicinal and aromatic plants in a planned and controlled way and for optimum benefit.
- From the biodiversity conservation point of view the “collection practices” part of the guidelines is important since it relates to wildcrafting.
- Collection practice is aimed to ensure the long term survival of wild populations and their associated habitats.

Collection and postharvest treatment

- The guidelines sets the rules for sustainable collection of plants from their wild habitats as well as their post harvest processing, bulk packaging and labelling, storage and transportation, equipment, personel, quality assurance, documentation, etc.
- There are also ethical and legal considerations, issues on intellectual property rights and benefit sharing, threatened and endangered species and research needs.

Drying of aromatic plants

- Post harvest treatment of aromatic plant drugs require extra care.
- Due to volatile nature of their active constituents they should be dried in the shade as quickly as possible.
- For plants containing superficial oils such as marjoram, temperature of the drying air should not exceed 45°C.

Drying of aromatic plants

- With the temperature of 60°C and the drying time of 3-4 h the oil content is reduced by 10%.
- With an air temperature of 70° C and after 1 h drying time, oil content is reduced by 25% and the colour of the material changes.
- However, parsley and dill which contain subcutaneous oils may be dried at this temperature without loss of oil and natural colour.

Drying of aromatic plants

- If fast drying is preferred for Labiatae plants (*e.g.*, peppermint), drying to a final moisture content of 10% with air temperature of 60°C, 4 h is enough at the expense of 10-20% oil loss.
- Descending the temperature to 50°C doubles the time needed to 8 to 10 h. with 40°C, the drying time rises to 24 h.

Drying of aromatic plants

- Ambient air drying with average temperatures of 20 – 25°C and high relative humidity is not recommended.
- Under such conditions drying may be extended to a week.
- Longer drying times require more attention to the drying process.

Storage

- Aromatic plant drugs should be stored intact, not crushed or powdered as much as possible since it may reduce their volatiles content and expose them to the danger of oxidation.
- Some may be cut into smaller pieces before storage.
- Their oil content and microbial counts should be regularly checked during long storage periods.

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Storage

- Essential oils should be kept in hermetically sealed dark glass, aluminium or steel containers at cooler than ambient temperatures.
- Refrigeration (*below 4°C*) may not be necessary. If required it should be between 5-15 °C (*Ave. 10 °C*).

Quality control

- Due to volatile nature of their active ingredients, quality control of aromatic plant drugs is extremely important.
- In order to safeguard their quality, standards and specifications exist in national and international Standard monographs as well as pharmacopoeias and codices.

Quality control

- The last (8th) edition of the European Pharmacopoeia effective since 2014 contains over 250 monographs on medicinal and aromatic plant drugs, extracts and essential oils.

Quality control

Commission Sessions		8 th Edition Supplements	Publication Schedule	Implementation Date
Session N ^o	Date			
–	–	8th Edition	15 July 2013	1 Jan. 2014
145	Mar. 2013	8.1	1 Oct. 2013	1 Apr. 2014
146	June 2013	8.2	1 Jan. 2014	1 July 2014
147	Nov. 2013	8.3	1 July 2014	1 Jan. 2015
148	Mar. 2014	8.4	1 Oct. 2014	1 Apr. 2015
149	June 2014	8.5	1 Jan. 2015	1 July 2015
150	Nov. 2014	8.6	1 July 2015	1 Jan. 2016
151	Mar. 2015	8.7	1 Oct. 2015	1 Apr. 2016
152	June 2015	8.8	1 Jan. 2016	1 July 2016
153	Nov. 2015	9th Edition	15 July 2016	1 Jan. 2017

Quality control

Essential Oil monographs in European Pharmacopoeia (7.5)

Anis oil; Star anise oil; Sweet orange oil; Caraway oil; Clove oil; Cassia (Chinese cinnamon) oil; Cinnamon bark, Ceylon oil; Cinnamon leaf, Ceylon oil; Mandarin (peel) oil; Citronella oil; Coriander seed oil; Eucalyptus oil; Bitter fennel fruit oil; Bitter fennel herb oil; Juniper oil; Lavender oil; Lemon (peel) oil; Matricaria (Chamomile) oil; Teatree oil; Mint oil, partly dementholized; Peppermint oil; Nutmeg oil; Neroli oil; Dwarf pine oil; Pine sylvestris oil; Rosemary oil; Spanish sage oil; Clarysage oil; Spike lavender oil; Turpentine oil, *Pinus pinaster* type; Thyme oil

Quality control

Pharmacopoeial monograph of an aromatic plant consists of :

- **Definition:** Correct botanical identity of the source plant with complete scientific Latin name, plant part used, state of the drug (**whole, fragmented, cut, fresh or dry**), where appropriate the time of harvesting, where appropriate the minimum content of quantified constituents should be indicated in the definition.

ANISEED

EUROPEAN PHARMACOPOEIA 5.0

01/2005:0262

ANISEED
Anisi fructus

DEFINITION
Aniseed consists of the whole dry cremocarp of *Pimpinella anisum* L. It contains not less than 20 ml/kg of essential oil.

CHARACTERS
Aniseed has an odour reminiscent of anethole.
The fruit is a cremocarp and generally entire; a small fragment of the thin, rigid, slightly curved pedicel is frequently attached.
It has the macroscopic and microscopic characters described under identification tests A and B.

IDENTIFICATION
A. The cremocarp is ovoid or pyriform and slightly compressed laterally, yellowish-green or greenish-grey, 3 mm to 5 mm long and up to 3 mm wide, surmounted by a stylopod with 2 short, reflexed stylar points. The mericarps are attached by their tops to the carpophore with a plane commissural surface and a convex distal surface, the latter being covered with short, warty trichomes visible using a lens; the fruit shows 5 primary ridges, running longitudinally, comprising 2 dorsal ridges and 2 lateral ridges, non-prominent, and lighter in colour.
B. Reduce to a powder (355). The powder is greenish-yellow to brownish-green. Examine under a microscope using chloral hydrate solution R. The powder shows the following diagnostic characters: whole or broken trichomes, mostly unicellular, sometimes curved, with blunt apex and warty outside; fragments of epidermis with striated cuticle, occasional anomocytic stomata; fragments of numerous narrow, branched villae; fragments of endosperm containing aleurone grains and micro-rosettes of calcium oxalate; oblong sclereids from the commissural zone and bundles of sclerenchymatous fibres from the carpophore and the pedicel. Starch is absent.
C. Examine by thin-layer chromatography (2.2.27), using silica gel GF₂₅₄ R as the coating substance.
Test solution. Shake 0.10 g of the powdered drug (1500) with 2 ml of methylene chloride R for 15 min. Filter and carefully evaporate the filtrate to dryness on a water-bath at 60 °C. Dissolve the residue in 0.5 ml of toluene R.
Reference solution. Dissolve 3 µl of anethole R and 40 µl of olive oil R in 1 ml of toluene R.
Apply to the plate at 2 cm intervals 2 µl and 3 µl of the test solution and 1 µl, 2 µl and 3 µl of the reference solution. Develop over a path of 10 cm using toluene R. Allow the plate to dry in air and examine in ultraviolet light at 254 nm. The chromatograms show a quenching zone (anethole) in the central part against a light background. Spray the plate with a freshly prepared 200 g/l solution of phosphomolybdic acid R in alcohol F, using 10 ml for a plate 200 mm square, and heat at 120 °C for 5 min. The spots corresponding to anethole appear blue against a yellow background. In the chromatogram obtained with 2 µl of the test solution, the spot corresponding to anethole is intermediate in size between the spots corresponding to anethole in the chromatograms obtained with 1 µl and 3 µl of the reference solution. The chromatograms obtained with the test solution show in the lower third a blue spot (triglycerides) similar in position to the spot in the lower third of the chromatograms obtained with the reference solution (triglycerides of olive oil).

TESTS
Foreign matter (2.8.2). It complies with the test for foreign matter.
Water (2.2.17). Not more than 70 ml/kg, determined by distillation on 20.0 g of the powdered drug.
Total ash (2.4.16). Not more than 12.0 per cent.
Ash insoluble in hydrochloric acid (2.8.1). Not more than 2.5 per cent.

ASSAY
Carry out the determination of essential oils in vegetable drugs (2.8.12). Use a 250 ml round-bottomed flask, 100 ml of toluene R as the distillation liquid and 0.50 ml of xylene R in the graduated tube. Reduce the drug to a coarse powder and immediately use 10.0 g for the determination. Distill at a rate of 2.5-3.5 ml/min for 2 h.

STORAGE
Store protected from light.

01/2005:0972

ANTAZOLINE HYDROCHLORIDE
Antazolini hydrochloridum

C1=CC=C2C(=C1)N(C2)C3=CN=C(N3)Cl

$C_{10}H_{10}ClN_2$ M_r 301.8

DEFINITION
Antazoline hydrochloride contains not less than 99.0 per cent and not more than the equivalent of 101.0 per cent of Nbenzyl-N[4,5-dihydro-1Himidazol-2-(5-methyl)anilin]hydrochloride, calculated with reference to the dried substance.

CHARACTERS
A white or almost white, crystalline powder, sparingly soluble in water, soluble in alcohol, slightly soluble in methylene chloride.
It melts at about 240 °C, with decomposition.

IDENTIFICATION
First identification: A, D.
Second identification: B, C, D.
A. Examine by infrared absorption spectrophotometry (2.2.24), comparing with the spectrum obtained with antazoline hydrochloride CRS. Examine the substances as discs prepared using potassium chloride R.
B. Examine the chromatograms obtained in the test for related substances in daylight after spraying. The principal spot in the chromatogram obtained with test

1006 See the information section on general monographs (cover page)

Quality control

Organoleptic characters: The colour of the drug may be described.

- No reference is made to odour or to taste unless bitterness value is determined.

Macroscopic and microscopic tests: These are included in the Identifications section and are necessary to authenticate the material and to detect adulterants if any.

- Chemical identification tests may be required.

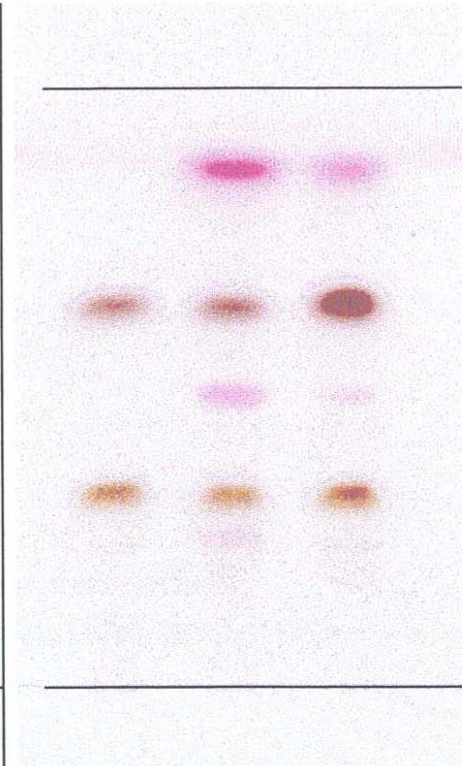
Quality control

- Thin layer chromatography is used in identification C, even if other chromatographic methods are used in the monograph.
- Only the principal zone(s) of the chromatogram obtained with the test solution are described in the table in relation to the position of the zones and their colour with the reagent used or under fluorescent light in the chromatogram obtained with the reference solution.

Quality control

TLC of Lavender Oil

Top of the plate	
	A violet zone
Linalyl acetate: a violet red zone	A violet-red zone
Linalol: a violet red zone	Possibly a weak violet-brown zone A violet red zone (linalol) A intense brownish-green zone
Reference solution	Test solution



Quality control

- TLC may also be indicated under tests to detect adulteration by plant species that are not part of the definition.
- The name of the unwanted plants or their constituents is used in the title of the test.
- The position and colour of the zone(s) of the constituents, which must be absent are described.

EUROPEAN PHARMACOPOEIA 5.0

Anise oil

Results: the chromatogram obtained with the test solution shows no pale blue to white fluorescent zone between the zones of coumarin and eugenol in the chromatogram obtained with the reference solution.

Foreign matter (2.8.2): maximum 5 per cent of leaf bases and stem bases, maximum 5 per cent of discoloured pieces and maximum 1 per cent of other foreign matter.

Loss on drying (2.2.32): maximum 10.0 per cent, determined on 1.000 g of the powdered drug (355) by drying in an oven at 100-105 °C for 2 h.

Total ash (2.4.16): maximum 10.0 per cent.

Ash insoluble in hydrochloric acid (2.8.1): maximum 2.0 per cent.

ASSAY
Carry out the determination of essential oils in vegetable drugs (2.8.12). Reduce the drug to a powder (500) and immediately use 40.0 g for the determination. Use a 2 litre round-bottomed flask, 10 drops of *liquid paraffin R*, 500 ml of *water R* as distillation liquid and 0.50 ml of *xylene R* in the graduated tube. Distil at a rate of 2-3 ml/min for 4 h.

01/2005:0804
corrected

ANISE OIL
Anisi aetheroleum

DEFINITION
Essential oil obtained by steam distillation from the dry ripe fruits of *Pimpinella anisum* L.

CHARACTERS
Appearance: clear, colourless or pale yellow liquid.

IDENTIFICATION
First identification: B.
Second identification: A.

A. Thin-layer chromatography (2.2.27).
Test solution. Dissolve 1 g of the substance to be examined in *toluene R* and dilute to 10 ml with the same solvent.
Reference solution. Dissolve 10 µl of *linalol R*, 30 µl of *anisaldehyde R* and 200 µl of *anethole R* in *toluene R* and dilute to 15 ml with the same solvent. Dilute 1 ml of this solution to 5 ml with *toluene R*.
Plate: TLC silica gel *F₂₅₄* plate *R*.
Mobile phase: *ethyl acetate R*, *toluene R* (793 V/V).
Application: 5 µl as bands of 10 mm (for normal TLC plates) or 2 µl as bands of 10 mm (for fine particle size plates).
Development: over a path of 15 cm (for normal TLC plates) or over a path of 6 cm (for fine particle size plates).
Drying: in air.
Detection A: examine in ultraviolet light at 254 nm.
Results A: see below the sequence of zones present in the chromatograms obtained with the reference solution and the test solution. Furthermore, other zones may be present in the chromatogram obtained with the test solution.

Top of the plate	
Anethole: a quenching zone	A very strong quenching zone (anethole)
	A quenching zone
Anisaldehyde: a quenching zone	A quenching zone (anisaldehyde)
Reference solution	Test solution

Detection B: spray with *methyl 4-acetylbenzoate reagent R* and heat at 100-105 °C for 10 min; examine the still hot plate in daylight within 5 min.
Results B: see below the sequence of zones present in the chromatograms obtained with the reference solution and the test solution. Furthermore, other zones may be present in the chromatogram obtained with the test solution.

Top of the plate	
Anethole: a brown zone	A violet-brown zone (monoterpene hydrocarbons) (solvent front)
	A very strong brown zone (anethole, distinctly separated)
Anisaldehyde: a yellow zone	A grey zone
	A yellow zone (anisaldehyde)
Linalol: a grey zone	A grey zone (linalol)
	A grey zone
Reference solution	Test solution

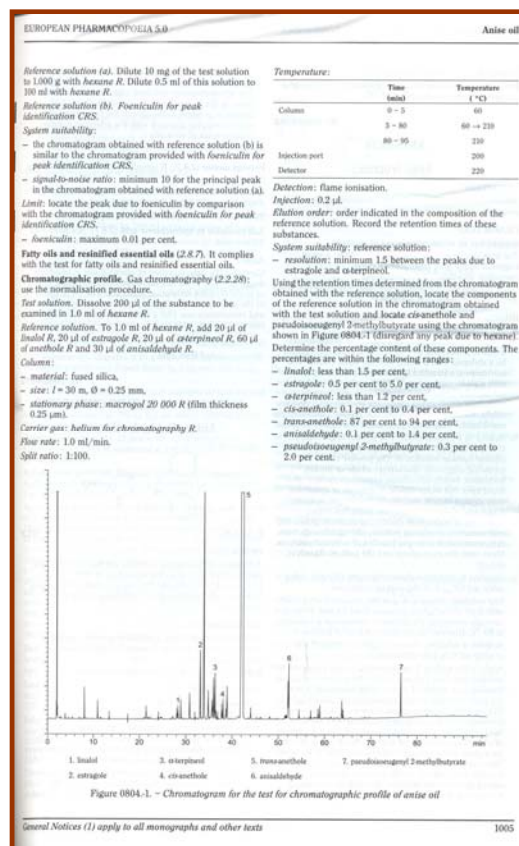
B. Examine the chromatograms obtained in the test for chromatographic profile.
Results: the characteristic peaks in the chromatogram obtained with the test solution are similar in retention time to those in the chromatogram obtained with the reference solution.

TESTS
Relative density (2.2.5): 0.980 to 0.990.
Refractive index (2.2.6): 1.552 to 1.561.
Freezing point (2.2.16): 15 °C to 19 °C.
Fenchone. Gas chromatography (2.2.28) as described in the test for chromatographic profile with the following modifications.
Test solution. Dissolve 400 µl of the substance to be examined in 2.0 ml of *hexane R*.
Reference solution (a). Dilute 10 µl of *fenchone R* to 1.2 g with *hexane R*.
Reference solution (b). Dilute 100 µl of reference solution (a) to 100 ml with *hexane R*.
System suitability: reference solution (b):
– *signal-to-noise ratio:* minimum 10 for the principal peak.
Limit:
– *fenchone:* maximum 0.01 per cent.
Foeniculin. Gas chromatography (2.2.28) as described in the test for chromatographic profile with the following modifications.
Test solution. The substance to be examined.

1004 See the information section on general monographs (cover pages)

Quality control

- Essential oil content is determined by water distillation of the dried plant material using a Clevenger type apparatus as indicated in the test methods.
- Gas chromatographic profile of the essential oil using a standard procedure is used for fingerprinting purposes.
- Percentage ranges of important constituents are also indicated in the case of essential oils.



Quality control

The allowable percentages of the chemical constituents in Anise oils

Chemical constituents

linalool

estragole

α-terpineol

cis-anethole

trans-anethole

anisaldehyde

Pseudoisoeugenyl 2-methylbutyrate

Allowable percentage

Maximum 1.5 percent

0.5 percent to 5.0 percent

Maximum 2.4 percent

0.1 percent to 0.4 percent

87 percent to 94 percent

0.1 percent to 1.4 percent

0.3 percent to 2.0 percent

Source: European Pharmacopoeia 7.0. Pp. 1050-1052

Quality control

Assay: An appropriate assay procedure may be carried out in instances where the active constituent is known.

- Foreign matter, extractable matter, loss on drying, water content, total ash, ash insoluble in hydrochloric acid, etc tests are carried out.
- For herbal drugs containing more than 10 ml/kg (**1 per cent**) of essential oil, the determination of water by distillation is carried out instead of the test for loss on drying.
- Bitterness value may be required for materials such as wormwood, yarrow, etc.
- It is useful to determine extractable matter if no constituent suitable for an assay is known.

Quality control

- For essential oils the following physical tests may be required:
 - a) moisture content,
 - b) specific gravity,
 - c) optical rotation,
 - d) refractive index,
 - e) residue on evaporation,
 - f) freezing or congealing point,
 - g) solubility in dilute alcohol.
- Chemical tests such as acid value, carbonyl value, ester value, ester value after acetylation may be employed.

Quality control

- Gas chromatography (**GC**) is the most important technique for the separation of essential oil constituents and their quantitation.
- Gas chromatography/mass spectrometry (**GC/MS**) may only be necessary to identify constituents which appear unexpectedly in a known essential oil or for the analysis of new essential oils.

[KHC Baser, Analysis and quality assessment of essential oils. In: A Manual on the Essential Oil Industry, KT de Silva (Ed), UNIDO, Vienna (1995).

Quality control

- General monographs in the European Pharmacopoeia include extracts (*extracta*), herbal drugs (*planta medicinales*), herbal drug preparations (*plantae medicinales praeparatore*), herbal teas (*Plantae ad ptisanam*), essential oils (*Olea aetherea*), vegetable fatty oils (*Olea herbaria*).

*The European Pharmacopoeia basically defines the following type of extracts: dry extracts (*extracta sicca*), soft extracts (*extracta spissa*), liquid extracts (*extracta fluida*), tinctures (*tinctura*).*

Regulatory issues

- In Europe, the so-called “herbal medicinal products” contain pharmaceutically processed preparations from medicinal plants.
- They are offered in modern dosage forms such as tablets, coated tablets, capsules, drops, herbal teas, etc.
- In a formulation, a plant drug is considered a single ingredient (or an active compound) although it may contain numerous constituents.

Regulatory issues

- On the other hand, single substances isolated from plants (*e.g.*, menthol, camphor, 1,8-cineole, etc.) are not regarded as herbal medicinal products.
- In Germany, herbal medicinal products have to go through the same regulatory requirements as chemical drugs to prove their quality, safety and efficacy.

Regulatory issues

- In Europe, Traditional Herbal Medicinal Products, a different category, have to satisfy the following requirement: A THMP can only be registered if it has been in use in Europe for the last 15 years or et least 30 years in the World.
- This has to be proven by literature data or by the report of an expert.

Regulatory issues

- Even though a herbal preparation may have a large therapeutic index, rare side effects and interactions, therefore generally regarded as safe, affirmed data are necessary for its marketing authorization.
- These data can be derived from pharmacotoxicological and clinical reports or the so-called “further scientific knowledge material” such as monographs, experience reports, bibliographies, etc.

Regulatory issues

- In order to facilitate the assessment of marketing applications for herbal medicinal products, in 1978 the German Federal Health Agency (now German Federal Institute for Drugs and Medical Devices – BfArM) established a committee of experts called “Commission E” to evaluate safety of plant drugs in the German market.

Regulatory issues

- The Committee by 1994, had issued 433 monographs on plant drugs and combinations including *ca.* 200 approved herbs.
- These monographs contain descriptions of the plant products, their contents, pharmacological properties, accepted indications, contraindications, adverse effects, interactions with other drugs, dosage, quality requirements and recommended storage conditions.

K.H.C. Başer, New trends in the utilization of medicinal and aromatic plants, *Acta Horticulturae*, 676, 11-23 (2005).

M.Blumenthal, W.R.Busse, A.Goldberg, J.Grünwald, T. Hall, C.W.Riggins, R.S.Rister, *The Complete German Commission E Monographs: Therapeutic Guide to Herbal Medicines*, American Botanical Council, Austin (1998)

Regulatory issues

- Since the reviewing and updating of monographs by Commission E was ceased, monographs issued by the European Pharmacopoeia, ESCOP, WHO, British Herbal Pharmacopoeia, Chinese Pharmacopoeia, Indian Pharmacopoeia, Japanese Pharmacopoeia, Chinese Herb Monographs and Analysis (Wagner & Bauer), European Union Herbal Monographs, etc. are regarded as important treatises of many medicinal and aromatic plant drugs.

Regulatory issues

- Under the European Medicines Agency (EMA), Herbal Medicinal Products Committee (HMPC) prepares Community Monographs on herbal drugs to be used as reference in the registration of Herbal Medicinal Products and Traditional Herbal Medicinal Products in European countries.

http://ec.europa.eu/health/human-use/herbal-medicines/index_en.htm

or

http://www.ema.europa.eu/ema/index.jsp?curl=pages/medicines/landing/herbal_medicines_search_landing_page.jsp&mid=

Regulatory issues

- In the 8th edition of the European Pharmacopoeia (8.6 - 2016),
there are monographs on
 - 114 aromatic plant drugs including 34 essential oils.



Sources of important essential oils

Name	Species	Family	Used part	Wild/Cult	Trade vol.
Ambrette seed	<i>Hibiscus abelmoschus</i> L.	Malvaceae	seed	cult	LQ
Amyris	<i>Amyris balsamifera</i> L.	Rutaceae	wood	wild	LQ
Angelica root	<i>Angelica archangelica</i> L.	Apiaceae	root	cult	LQ
Anise seed	<i>Pimpinella anisum</i> L.	Apiaceae	fruit	cult	LQ
Armoise	<i>Artemisia herba-alba</i> Asso	Asteraceae	herb	Cult/wild	LQ
Asafoetida	<i>Ferula assa-foetida</i> L.	Apiaceae	resin	wild	LQ
Basil	<i>Ocimum basilicum</i> L.	Lamiaceae	Herb	Cult	LQ
Bay	<i>Pimenta racemosa</i> Moore	Myrtaceae	Leaf	Cult	LQ
Bergamot	<i>Citrus aurantium</i> L. subsp. <i>bergamia</i> (Risso et Poit.) Engl.	Rutaceae	Fruit peel	Cult	MQ
Birch tar	<i>Betula pendula</i> Roth. [syn. <i>B. verrucosa</i> Erhart. <i>B. alba</i> sensu H.J.Coste non L.]	Betulaceae	Bark, wood	Wild	LQ
Buchu leaf	<i>Agathosma betulina</i> (Bergius) Pillans, <i>A. crenulata</i> (L.) Pillans	Rutaceae	Leaf	Wild	LQ

HQ...high quantities (>1000 t/a). MQ....medium quantities (100-1000 t/a). LQ....low quantities (<100 t/a)

Sources of important essential oils

Name	Species	Family	Used part	Wild/Cult	Trade vol.
Cade	<i>Juniperus oxycedrus</i> L.	Cupressaceae	Wood	Wild	LQ
Cajuput	<i>Melaleuca leucadendron</i> L.	Myrtaceae	Leaf	Wild	LQ
Calamus	<i>Acorus calamus</i> L.	Araceae	Rhizome	Cult/wild	LQ
Camphor	<i>Cinnamomum camphora</i> (L.) J. Presl.	Lauraceae	Wood	Cult	LQ
Cananga	<i>Cananga odorata</i> Hook. F. et Thoms.	Annonaceae	Flower	Wild	LQ
Caraway	<i>Carum carvi</i> L.	Apiaceae	Fruit	Cult	LQ

HQ...high quantities (>1000 t/a). MQ....medium quantities (100-1000 t/a). LQ....low quantities (<100 t/a)

Sources of important essential oils

Name	Species	Family	Used part	Wild/Cult	Trade vol.
Cardamom	<i>Elettaria cardamomum</i> (L.) Maton	Zingiberaceae	Seed	Cult	LQ
Carrot seed	<i>Daucus carota</i> L.	Apiaceae	Fruit	Cult	LQ
Cascarilla	<i>Croton eluteria</i> (L.) Wright	Euphorbiaceae	Bark	Wild	LQ
Cedarwood, Chinese	<i>Cupressus funebris</i> Endl.	Cupressaceae	Wood	Wild	MQ
Cedarwood. Texas	<i>Juniperus mexicana</i> Schiede	Cupressaceae	Wood	Wild	MQ
Cedarwood, Virginia	<i>Juniperus virginiana</i> L.	Cupressaceae	Wood	Wild	MQ
Celery seed	<i>Apium graveolens</i> L.	Apiaceae	Fruit	Cult	LQ
Chamomile	<i>Matricaria recutita</i> L.	Asteraceae	Flower	Cult	LQ
Chamomile, Roman	<i>Anthemis nobilis</i> L.	Asteraceae	Flower	Cult	LQ
Chenopodium	<i>Chenopodium ambrosioides</i> (L.) Gray	Chenopodiaceae	Seed	Cult	LQ
Cinnamomum bark, Ceylon	<i>Cinnamomum zeylanicum</i> Nees	Lauraceae	Bark	Cult	LQ

HQ...high quantities (>1000 t/a). MQ....medium quantities (100-1000 t/a). LQ....low quantities (<100 t/a)

Sources of important essential oils

Name	Species	Family	Used part	Wild/Cult	Trade vol.
Cinnamomum bark, Chinese	<i>Cinnamomum cassia</i> Blume	Lauraceae	Bark	Cult	LQ
Cinnamon leaf	<i>Cinnamomum zeylanicum</i> Nees	Lauraceae	Leaf	Cult	LQ
Citronella, Ceylon	<i>Cymbopogon nardus</i> (L.) W. Wats..	Poaceae	Leaf	Cult	HQ
Citronella, Java	<i>Cymbopogon winterianus</i> Jowitt.	Poaceae	Leaf	Cult	HQ
Clarysage	<i>Salvia sclarea</i> L.	Lamiaceae	Flowering herb	Cult	MQ
Clove buds	<i>Syzygium aromaticum</i> (L.) Merrill et L.M. Perry	Myrtaceae	bud	Cult	LQ
Clove leaf	<i>Syzygium aromaticum</i> (L.) Merrill et L.M. Perry	Myrtaceae	Leaf	Cult	HQ
Coriander	<i>Coriandrum sativum</i> L.	Apiaceae	Fruit	Cult	LQ
Cornmint	<i>Mentha canadensis</i> L. [syn. <i>M. arvensis</i> L. f. <i>piperascens</i> Malinv. ex Holmes, <i>M. arvensis</i> L. var. <i>glabrata</i> Fernald, <i>M. haplocalyx</i> Briq., <i>M. saccalinensis</i> (Briq.) Kudo]	Lamiaceae	Leaf	Cult	HQ

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Sources of important essential oils

Name	Species	Family	Used part	Wild/Cult	Trade vol.
Cumin	<i>Cuminum cyminum</i> L.	Apiaceae	Fruit	Cult	LQ
Cypress	<i>Cupressus sempervirens</i> L.	Cupressaceae	Leaf, twig	Wild	LQ
Davana	<i>Artemisia pallens</i> Wall.	Asteraceae	Flowering herb	Cult	LQ
Dill	<i>Anethum graveolens</i> L.	Apiaceae	Herb/fruit	Cult	LQ
Dill, Indian	<i>Anethum sowa</i> Roxb.	Apiaceae	Fruit	Cult	LQ
Elemi	<i>Canarium luzonicum</i> Miq.	Burseraceae	Resin	Wild	LQ
Eucalyptus	<i>Eucalyptus globulus</i> Labill.	Myrtaceae	Leaf	Cult/wild	HQ
Eucalyptus, Lemon scented	<i>Eucalyptus citriodora</i> Hook.	Myrtaceae	Leaf	Cult/wild	HQ
Fennel, bitter	<i>Foeniculum vulgare</i> Mill. subsp. <i>vulgare</i> var. <i>vulgare</i>	Apiaceae	Fruit	Cult	JQ
Fennel, sweet	<i>Foeniculum vulgare</i> Mill. subsp. <i>vulgare</i> var. <i>dulce</i> (Mill.) Batt.	Apiaceae	Fruit	Cult	LQ
Fir needle, Canadian	<i>Abies balsamea</i> Mill.	Pinaceae	Leaf, twig	Wild	LQ

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Sources of important essential oils

Name	Species	Family	Used part	Wild/Cult	Trade vol.
Fir needle, Siberian	<i>Abies sibirica</i> Ledeb.	Pinaceae	Leaf, twig	Wild	LQ
Galbanum	<i>Ferula galbaniflua</i> Boiss. , <i>F. rubricaulis</i> Boiss.	Apiaceae	Resin	Wild	LQ
Garlic	<i>Allium sativum</i> L.	Alliaceae	Bulb	Cult	LQ
Geranium	<i>Pelargonium</i> spp.	Geraniaceae	Leaf	Cult	MQ
Ginger	<i>Zingiber officinale</i> Roscoe	Zingiberaceae	Rhizome	Cult	LQ
Gingergrass	<i>Cymbopogon martinii</i> (Roxb.) H. Wats var. <i>sofia</i> Burk	Poaceae	Leaf	Cult/wild	HQ
Grapefruit	<i>Citrus x paradisi</i> Macfad.	Myrtaceae	Leaf	Cult/wild	HQ
Guaiac	<i>Guaiacum officinale</i> L.	Zygophyllaceae	Resin	Wild	LQ
Guaiacwood	<i>Bulnesia sarmienti</i> L.	Zygophyllaceae	Wood	Wild	MQ
Gurjun	<i>Dipterocarpus</i> spp.	Dipterocarpaceae	Balsam	Wild	LQ
Hop	<i>Humulus lupulus</i> L.	Cannabaceae	Flower	Cult	LQ
Hyssop	<i>Hyssopus officinalis</i> L.	Lamiaceae	Leaf	Cult	LQ
Juniper berry	<i>Juniperus communis</i> L.	Cupressaceae	Fruitqwild	LQ	

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Sources of important essential oils

Name	Species	Family	Used part	Wild/Cult	Trade vol.
Laurel leaf	<i>Laurus nobilis</i> L.	Lauraceae	Leaf	Cult/wild	LQ
Lavandin	<i>Lavandula angustifolia</i> Mill. X <i>L. latifolia</i> Medik.	Lamiaceae	Flower	Cult	HQ
Lavender	<i>Lavandula angustifolia</i> Miller	Lamiaceae	Flower	Cult	MQ
Lavender, spike	<i>Lavandula latifolia</i> Medik.	Lamiaceae	Flower	Cult	LQ
Lemon	<i>Citrus limon</i> (L.) Burman fil.	Rutaceae	Fruit peel	Cult	HQ
Lemongrass, Indian	<i>Cymbopogon flexuosus</i> (Nees ex Steud.) H. Wats.	Poaceae	Leaf	Cult	HQ
Lemongrass, West Indian	<i>Cymbopogon citratus</i> (DC.) Stapf.	Poaceae	Leaf	Cult	HQ
Lime distilled	<i>Citrus aurantiifolia</i> (Christm. et Panz.) Swingle	Rutaceae	Fruit	Cult	HQ
Litsea cubeba	<i>Litsea cubeba</i> C.H. Persoon	Lauraceae	Fruit/leaf	Cult	MQ
Lovage root	<i>Levisticum officinale</i> Koch	Apiaceae	Root	Cult	LQ

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Sources of important essential oils

Name	Species	Family	Used part	Wild/Cult	Trade vol.
Mandarin	<i>Citrus reticulata</i> Blanco	Rutaceae	Fruit pell	Cult	MQ
Marjoram	<i>Origanum majorana</i> L.	Lamiaceae	Herb	Cult	LQ
Mugwort, Common	<i>Artemisia vulgaris</i> L.	Asteraceae	Herb	Cult/wild	LQ
Mugwort, Roman	<i>Artemisia pontica</i> L.	Asteraceae	Herb	Cult/wild	LQ
Myrtle	<i>Myrtus communis</i> L.	Myrtaceae	Leaf	Cult/wild	LQ
Neroli	<i>Citrus aurantium</i> L. subsp. <i>aurantium</i>	Rutaceae	Flower	Cult	LQ
Niaouli	<i>Melaleuca viridiflora</i> Sol. ex Gaertn.	Myrtaceae	Leaf	Cult/wild	LQ
Nutmeg	<i>Myristica fragrans</i> Houtt.	Myristicaceae	Seed	Cult	LQ
Onion	<i>Allium cepa</i> L.	Alliaceae	Bulb	Cult	LQ
Orange	<i>Citrus sinensis</i> (L.) Osbeck	Rutaceae	Fruit peel	Cult	HQ
Orange, bitter	<i>Citrus aurantium</i> L.	Rutaceae	Fruit peel	Cult	LQ

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Sources of important essential oils

Name	Species	Family	Used part	Wild/Cult	Trade vol.
Oregano	<i>Origanum</i> spp., <i>Thymbra spicata</i> L., <i>Coridothymus capitatus</i> Rchb. f., <i>Lippia graveolens</i> Kunth, <i>Satureja</i> spp.	Lamiaceae	Herb	Cult/wild	LQ
Palmarosa	<i>Cymbopogon martini</i> (Roxb.) H. Wats. var. <i>motia</i> Burk	Poaceae	Leaf	Cult	LQ
Parsley seed	<i>Petroselinum crispum</i> (Mill.) Nym. ex A.W. Hill	Apiaceae	Fruit	Cult	LQ
Patchouli	<i>Pogostemon cablin</i> (Blanco) Benth.	Lamiaceae	Leaf	Cult	HQ
Pennyroyal	<i>Mentha pulegium</i> L.	Lamiaceae	Herb	Cult	LQ
Pepper	<i>Piper nigrum</i> L.	Piperaceae	Fruit	Cult	LQ
Peppermint	<i>Mentha x piperita</i> L.	Lamiaceae	Leaf	Cult	HQ
Pimento	<i>Pimenta dioica</i> (L.) Merr.	Myrtaceae	Fruit	Cult	LQ
Pine needle	<i>Pinus silvestris</i> L., <i>P. nigra</i> Arnold	Pinaceae	Leaf, twig	Wild	LQ

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Sources of important essential oils

Name	Species	Family	Used part	Wild/Cult	Trade vol.
Pine needle, dwarf	<i>Pinus mugo</i> Turra	Pinaceae	Leaf, twig	Wild	LQ
Pine silvestris	<i>Pinus silvestris</i> L.	Pinaceae	Leaf, twig	Wild	LQ
Pine, White	<i>Pinus palustris</i> Mill.	Pinaceae	Leaf, twig	Wild	LQ
Rose	<i>Rosa x damascena</i> Miller	Rosaceae	Flower	Cult	LQ
Rosemary	<i>Rosmarinus officinalis</i> L.	Lamiaceae	Leaf	Cult/wild	LQ
Rosewood	<i>Aniba rosaeodora</i> Ducke	Lauraceae	Wood	Wild	LQ
Rue	<i>Ruta graveolens</i> L.	Rutaceae	Herb	Cult	LQ
Sage, Dalmatian	<i>Salvia officinalis</i> L.	Lamiaceaeq	Herb	Cult/wild	LQ
Sage, Spanish	<i>Salvia lavandulifolia</i> L.	Lamiaceae	Leaf	Cult	LQ
Sage, trilobed (Turkish, Greek)	<i>Salvia fruticosa</i> Mill. [syn. <i>S. triloba</i> L.]	Lamiaceae	Herb	Cult/wild	LQ
Sandalwood, East Indian	<i>Santalum album</i> L.	Santalaceae	Wood	Wild	MQ

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Sources of important essential oils

Name	Species	Family	Used part	Wild/Cult	Trade vol.
Sassafras, Brazilian (Ocotea cymbarum oil)	<i>Ocotea odorifera</i> (Vell.) Rohwer [<i>O. pretiosa</i> (Nees) Mez.]	Lauraceae	Wood	Wild	HQ
Sassafras, Chinese	<i>Sassafras albidum</i> (Nutt.) Nees.	Lauraceae	Rootbark	Wild	HQ
Savory	<i>Satureja hortensis</i> L., <i>S. montana</i> L.	Lamiaceae	Leaf	Cult/wild	LQ
Spearmint, native	<i>Mentha spicata</i> L.	Lamiaceae	Leaf	Cult	MQ
Spearmint, Scotch	<i>Mentha gracilis</i> Sole	Lamiaceae	Leaf	Colt	HQ
Star anise	<i>Illicium verum</i> Hook f.	Illiciaceae	Fruit	Cult	MQ
Storax	<i>Liquidambar orientalis</i> Mill, <i>L. styraciflua</i> L.	Hamamelidaceae	Balsam	Wild	LQ
Tansy	<i>Tanacetum vulgare</i> L.	Asteraceae	Flowering herb	Cult/wild	LQ
Tarragon	<i>Artemisia dracunculus</i> L.	Asteraceae	Herb	Cult	LQ
Teatree	<i>Melaleuca</i> spp.	Myrtaceae	Leaf	Cult	LQ

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Sources of important essential oils

Name	Species	Family	Used part	Wild/Cult	Trade vol.
Thyme	<i>Thymus vulgaris</i> L., <i>T. zygis</i> Loefl. ex L.	Lamiaceae	Herb	Cult	LQ
Valerian	<i>Valeriana officinalis</i> L.	Valerianaceae	Root	Cult	LQ
Vetiver	<i>Vetiveria zizanooides</i> (L.) Nash	Poaceae	Root	Cult	MQ
Wintergreen	<i>Gaultheria procumbens</i> L.	Ericaceae	Leaf	Wild	LQ
Wormwood	<i>Artemisia absinthium</i> L.	Asteraceae	Herb	Cult/wild	LQ
Ylang Ylang	<i>Cananga odorata</i> Hook f. et Thoms.	Annonaceae	Flower	Cult	MQ

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