

Essential oil

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An **essential oil** is a concentrated hydrophobic liquid containing volatile aroma compounds from plants. Essential oils are also known as **volatile oils**, **ethereal oils**, **aetherolea**, or simply as the **oil of the plant** from which they were extracted, such as oil of clove. An oil is "essential" in the sense that it contains the "essence of" the plant's fragrance—the characteristic fragrance of the plant from which it is derived.^[1] The term essential used here does not mean indispensable as with the terms essential amino acid or essential fatty acid which are so called since they are nutritionally required by a given living organism.^[2]

Essential oils are generally extracted by distillation, often by using steam. Other processes include expression, solvent extraction, absolute oil extraction, resin tapping, and cold pressing. They are used in perfumes, cosmetics, soaps and other products, for flavoring food and drink, and for adding scents to incense and household cleaning products.

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History

Essential oils have been used medicinally throughout history. Medical applications proposed by those who sell medicinal oils range from skin treatments to remedies for cancer and often are based solely on historical accounts of use of essential oils for these purposes. Claims for the efficacy of medical treatments, and treatment of cancers in particular, are now subject to regulation in most countries.

As the use of essential oils has declined in evidence-based medicine, one must consult older textbooks for much information on their use.^{[3][4]} Modern works are less inclined to generalize; rather than refer to "essential oils" as a class at all, they prefer to discuss specific compounds, such as methyl salicylate, rather than "oil of wintergreen".^{[5][6]}

Interest in essential oils has revived in recent decades with the popularity of aromatherapy, a branch of alternative medicine that claims that essential oils and other aromatic compounds have curative effects. Oils are volatilized or diluted in a carrier oil and used in massage, diffused in the air by a nebulizer, heated over a candle flame, or burned as incense.

The earliest recorded mention of the techniques and methods used to produce essential oils is believed to be that of Ibn al-Baitar (1188–1248), an Al-Andalusian (Muslim-controlled Spain) physician, pharmacist and chemist.^[7]

Production

Distillation

Today, most common essential oils—such as lavender, peppermint, tea tree oil, patchouli, and eucalyptus—are distilled. Raw plant material, consisting of the flowers, leaves, wood, bark, roots, seeds, or peel, is put into an alembic (distillation apparatus) over water. As the water is heated, the steam passes through the plant material, vaporizing the volatile compounds. The vapors flow through a coil, where they condense back to liquid, which is then collected in the receiving vessel.

Most oils are distilled in a single process. One exception is *ylang-ylang* (*Cananga odorata*), which takes 22 hours to complete through a fractional distillation.

The recondensed water is referred to as a hydrosol, hydrolat, herbal distillate or plant water essence, which may be sold as another fragrant product. Popular hydrosols include rose water, lavender water, lemon balm, clary sage and orange blossom water. The use of herbal distillates in cosmetics is increasing. Some plant hydrosols have unpleasant smells and are therefore not sold.

Expression

Most citrus peel oils are expressed mechanically or cold-pressed (similar to olive oil extraction). Due to the relatively large quantities of oil in citrus peel and low cost to grow and harvest the raw materials, citrus-fruit oils are cheaper than most other essential oils. Lemon or sweet orange oils that are obtained as byproducts of the citrus industry are even cheaper.

Before the discovery of distillation, all essential oils were extracted by pressing.^[8]

Solvent extraction

Most flowers contain too little volatile oil to undergo expression, but their chemical components are too delicate and easily denatured by the high heat used in steam distillation. Instead, a solvent such as hexane or supercritical carbon dioxide is used to extract the oils. Extracts from hexane and other hydrophobic solvents are called *concretes*, which are a mixture of essential oil, waxes, resins, and other lipophilic (oil-soluble) plant material.

Although highly fragrant, concretes contain large quantities of non-fragrant waxes and resins. Often, another solvent, such as ethyl alcohol, which is more polar in nature, is used to extract the fragrant oil from the concrete. The alcohol solution is chilled to -18 °C (0 °F) for more than 48 hours which causes the waxes and lipids to precipitate out. The precipitates are then filtered out and the ethanol is removed from the remaining solution by evaporation, vacuum purge, or both, leaving behind the *absolute*.

Supercritical carbon dioxide is used as a solvent in supercritical fluid extraction. This method has many benefits including avoiding petrochemical residues in the product and the loss of some "top notes" when steam distillation is used. It does not yield an absolute directly. The supercritical carbon dioxide will extract both the waxes and the essential oils that make up the concrete. Subsequent processing with liquid carbon dioxide, achieved in the same extractor by merely lowering the extraction temperature, will separate the waxes from the essential oils. This lower temperature process prevents the decomposition and denaturing of compounds. When the extraction is complete, the pressure is reduced to ambient and the carbon dioxide reverts to a gas, leaving no residue.

Supercritical carbon dioxide is also used for making decaffeinated coffee. Although it uses the same basic principles, it is a different process because of the difference in scale.

Florasols extraction

Florasol (1,1,1,2-tetrafluoroethane), a refrigerant, was developed to replace Freon. Although Florasol is an "ozone-friendly" product, it poses significant danger to the environment due to its global warming potential (GWP; 100-yr GWP = 1430).^[9] The European Union has banned its use, with a phase-out process that began in 2011, to be completed in 2017.^[10] One advantage is that the extraction of essential oils occurs at or below room temperature so degradation through high temperature extremes does not occur. The essential oils are mostly pure and contain little to no foreign substances.

Production quantities

Estimates of total production of essential oils are difficult to obtain. One estimate, compiled from data in 1989, 1990 and 1994 from various sources, gives the following total production, in tonnes, of essential oils for which more than 1,000 tonnes were produced.^[11]

Oil	Tonnes
Sweet orange	12,000
<i>Mentha arvensis</i>	4,800
Peppermint	3,200
Cedarwood	2,600
Lemon	2,300
<i>Eucalyptus globulus</i>	2,070
<i>Litsea cubeba</i>	2,000
Clove (leaf)	2,000
Spearmint	1,300

Pharmacology

Medicinal use of essential oils is seen as pseudoscience in the healthcare community.^[12] Despite the lack of proof that essential oils provide medicinal value, they retain considerable popular use among advocates of alternative medicine.

Studies have shown that certain essential oils may have the ability to prevent the transmission of some drug-resistant strains of pathogen, specifically *Staphylococcus*, *Streptococcus* and *Candida*.^[13]

Taken by mouth, many essential oils can be dangerous in high concentrations. Typical effects begin with a burning feeling, followed by salivation. In the stomach, the effect is carminative, relaxing the gastric sphincter and encouraging eructation (belching). Further down the gut, the effect typically is antispasmodic.^{[3][14]}

Typical ingredients for such applications include eucalyptus oils, menthol, capsaicin, anise and camphor. Other essential oils work well in these applications, but it is notable that others offer no significant benefit. This illustrates the fact that different essential oils may have drastically different pharmacology. Those that do work well for upper respiratory tract and bronchial problems act variously as mild expectorants and decongestants. Some act as locally anaesthetic counterirritants and, thereby, exert an antitussive effect.^{[3][15]}

Some essential oils, such as those of juniper and agathosma, are valued for their diuretic effects.^[16] With relatively recent concerns about the overuse of antibacterial agents,^[17] many essential oils have seen a resurgence in off-label use for such properties and are being examined for this use clinically.^[18]

Many essential oils affect the skin and mucous membranes in ways that are valuable or harmful. Many essential oils, particularly tea tree oil, may cause a contact dermatitis.^{[19][20][21][22]} They are used in antiseptics and liniments in particular. Typically, they produce rubefacient irritation at first and then counterirritant numbness. Turpentine oil and camphor are two typical examples of oils that cause such effects. Menthol and some others produce a feeling of cold followed by a sense of burning. This is caused by its effect on heat-sensing nerve endings. Some essential oils, such as clove oil or eugenol, were popular for many hundred years in dentistry as antiseptics and local anaesthetics. Thymol is well known for its antiseptic effects.

Use in aromatherapy

Aromatherapy is a form of alternative medicine in which healing effects are ascribed to the aromatic compounds in essential oils and other plant extracts. Aromatherapy appears to be useful to induce relaxation, especially when administered with massage.^[23] The Canadian Agency for Drugs and Technologies in Health stated that there is no evidence in favor of the clinical or cost effectiveness of essential oils as disinfectant agents or in aiding with wound healing.^[24] Use of essential oils may cause harm including allergic reactions and skin irritation; there has been at least one case of death.^[25]

Dilution

Essential oils are usually lipophilic (literally: "*oil-loving*") compounds that usually are not miscible with water. They can be diluted in solvents like pure ethanol and polyethylene glycol.

Raw materials

Essential oils are derived from sections of plants. Some plants, like the bitter orange, are sources of several types of essential oil.

<p>Bark</p> <ul style="list-style-type: none"> ■ Cassia ■ Cinnamon ■ Sassafras <p>Berries</p> <ul style="list-style-type: none"> ■ Allspice ■ Juniper <p>Flowers</p> <ul style="list-style-type: none"> ■ Cannabis ■ Chamomile ■ Clary sage ■ Clove ■ Scented geranium ■ Hops ■ Hyssop ■ Jasmine ■ Lavender ■ Manuka ■ Marjoram ■ Orange ■ Rose ■ Ylang-ylang 	<p>Leaves</p> <ul style="list-style-type: none"> ■ Basil ■ Bay leaf ■ Buchu ■ Cinnamon ■ Common sage ■ Eucalyptus ■ Guava ■ Lemon grass ■ Melaleuca ■ Oregano ■ Patchouli ■ Peppermint ■ Pine ■ Rosemary ■ Spearmint ■ Tea tree ■ Thyme ■ Tsuga ■ Wintergreen <p>Peel</p> <ul style="list-style-type: none"> ■ Bergamot ■ Grapefruit ■ Lemon ■ Lime ■ Orange ■ Tangerine 	<p>Resin</p> <ul style="list-style-type: none"> ■ Benzoin ■ Copaiba ■ Frankincense ■ Myrrh <p>Rhizome</p> <ul style="list-style-type: none"> ■ Galangal ■ Ginger <p>Root</p> <ul style="list-style-type: none"> ■ Valerian <p>Seeds</p> <ul style="list-style-type: none"> ■ Anise ■ Buchu ■ Celery ■ Cumin ■ Flax ■ Nutmeg oil <p>Wood</p> <ul style="list-style-type: none"> ■ Camphor ■ Cedar ■ Rosewood ■ Sandalwood ■ Agarwood
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Eucalyptus oil

Most Eucalyptus oil on the market is produced from the leaves of *Eucalyptus globulus*. Steam-distilled eucalyptus oil is used throughout Asia, Africa, Latin America and South America as a primary cleaning/disinfecting agent added to soaped mop and countertop cleaning solutions; it also possesses insect and limited vermin control properties. Note, however, there are hundreds of species of eucalyptus, and perhaps some dozens are used to various extents as sources of essential oils. Not only do the products of different species differ greatly in characteristics and effects, but also the products of the very same tree can vary grossly.^[4]

Rose oil

Rose oil is produced from the petals of *Rosa damascena* and *Rosa centifolia*. Steam-distilled rose oil is known as "rose otto", while the solvent extracted product is known as "rose absolute".

Lavender essential oil

Lavender essential oil has long been used in the production of perfume.^[26] However, it can be estrogenic and antiandrogenic, causing problems for prepubescent boys and pregnant women, in particular.^[27] Lavender essential oil is also used as an insect repellent.^[28]

Balsam of Peru

Balsam of Peru, an essential oil derived from the *Myroxylon*, is used in food and drink for flavoring, in perfumes and toiletries for fragrance, and in medicine and pharmaceutical items for healing properties.^[29] However, a number of national and international surveys have identified Balsam of Peru as being in the "top five" allergens most commonly causing patch test allergic reactions in people referred to dermatology clinics.^{[30][31][32]}

Dangers

The potential danger of an essential oil is sometimes relative to its level or grade of purity, and sometimes related to the toxicity of specific chemical components of the oil. Many essential oils are designed exclusively for their aroma-therapeutic quality; these essential oils generally should not be applied directly to the skin in their undiluted or "neat" form. Some can cause severe irritation, provoke an allergic reaction and, over time, prove hepatotoxic.

Some essential oils, including many of the citrus peel oils, are photosensitizers, increasing the skin's vulnerability to sunlight.^[33]

Industrial users of essential oils should consult the safety data sheets (SDS) to determine the hazards and handling requirements of particular oils. Even certain therapeutic grade oils can pose potential threats to individuals with epilepsy or pregnant women.

Handling

Exposure to essential oils may cause a contact dermatitis.^{[20][21][22]} Essential oils can be aggressive toward rubbers and plastics, so care must be taken in choosing the correct handling equipment. Glass syringes are often used, but have coarse volumetric graduations. Chemistry syringes are ideal, as they resist essential oils,

are long enough to enter deep vessels, and have fine graduations, facilitating quality control. Unlike traditional pipettes, which have difficulty handling viscous fluids, the chemistry syringe has a seal and piston arrangement which slides inside the pipette, wiping the essential oil off the pipette wall.

Pregnancy

The use of essential oils in pregnancy is not recommended due to inadequate published evidence to demonstrate evidence of safety.^[34] Pregnant women often report an abnormal sensitivity to smells and taste,^[35] and essential oils can cause irritation and nausea.

Gynecomastia

Estrogenic and antiandrogenic activity have been reported by *in vitro* study of tea tree oil and lavender essential oils. Case reports suggest the oils may be implicated in some cases of gynecomastia, an abnormal breast tissue growth, in prepubescent boys.^{[36][37]} However, these claims have been challenged^[38] and the European Commission's Scientific Committee on Consumer Safety has dismissed the claims saying "Since the hormonal active ingredients of Tea Tree Oil were shown not to penetrate the skin, the hypothesized correlation of the finding of 3 cases of gynecomastia to the topical use of Tea Tree Oil is considered implausible."^[39]

Pesticide residues

There is some concern about pesticide residues in essential oils, particularly those used therapeutically. For this reason, many practitioners of aromatherapy buy organically produced oils. Not only are pesticides present in trace quantities, but also the oils themselves are used in tiny quantities and usually in high dilutions. Where there is a concern about pesticide residues in food essential oils, such as mint or orange oils, the proper criterion is not solely whether the material is organically produced, but whether it meets the government standards based on actual analysis of its pesticide content.^[40]

Ingestion

Essential oils are used extensively as GRAS flavoring agents in foods, beverages and confectioneries according to strict Good Manufacturing Practice (GMP) and flavorist standards. Therapeutic grade essential oils are generally safe for human consumption in small amounts.^[41] Pharmacopoeia standards for medicinal oils should be heeded. Some oils can be toxic to some domestic animals, cats in particular.^[42] The internal use of essential oils can pose hazards to pregnant women, as some can be abortifacients in dose 0.5–10 ml, and thus should not be used during pregnancy.

Flammability

The flash point of each essential oil is different. Many of the common essential oils, such as tea tree, lavender, and citrus oils, are classed as a Class 3 Flammable Liquid, as they have a flash point of 50–60 °C.

Toxicology

The following table lists the LD₅₀ or median lethal dose for common oils; this is the dose required to kill half the members of a tested animal population. LD₅₀ is intended as a guideline only, and reported values can vary widely due to differences in tested species and testing conditions.^[43]

Common Name	Oral LD ₅₀	Dermal LD ₅₀	Notes
Neem	14 g/kg	>2 g/kg	
Lemon myrtle	2.43 g/kg	2.25 g/kg	
Frankincense	>5 g/kg	>5 g/kg	<i>Boswellia carterii</i>
Frankincense	>2 g/kg	>2 g/kg	<i>Boswellia sacra</i>
Indian frankincense	>2 g/kg	>2 g/kg	<i>Boswellia serrata</i>
Ylang-ylang	>5 g/kg	>5 g/kg	
Cedarwood	>5 g/kg	>5 g/kg	
Roman chamomile	>5 g/kg	>5 g/kg	
White camphor	>5 g/kg	>5 g/kg	<i>Cinnamomum camphora</i> , extracted from leaves
Yellow camphor	3.73 g/kg	>5 g/kg	<i>Cinnamomum camphora</i> , extracted from bark
Hot oil	3.80 g/kg	>5 g/kg	<i>Cinnamomum camphora</i> , oil extracted from leaves
Cassia	2.80 g/kg	0.32 g/kg	

Standardization of its derived products

In 2002, ISO published ISO 4720 in which the botanical names of the relevant plants are standardized.^[44] The rest of the standards with regards to this topic can be found in the section of ICS 71.100.60^[45]

See also

- Aroma lamp
- Enfleurage
- Fragrance oil
- Herb farm
- List of essential oils
- List of herbs
- List of vegetable oils
- Volatility



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