

Appendix 5. Quality criteria and specifications of eucalyptus oils

Introduction

Given the variability that can exist for eucalyptus oils, even when they are produced from the same botanical source, there is clearly a need for some sort of standard or specification for oils of commerce so that the buyer, or prospective buyer, knows what he can expect when he makes a purchase. The larger commercial producers, particularly those which export their oil, usually offer their own specifications and, if requested, these can be passed on by dealers or importers to their own customers. Once the link between producer and buyer is firmly established, and the latter has seen that successive consignments meet the needs and expectations of his end-user customers, subsequent orders can be placed on the basis of mutual trust. The end user or formulator will usually monitor purchases by undertaking appropriate quality control tests. For medicinal oils, 1,8-cineole content (among other things) is important, while for perfumery oils the content of some specific constituent such as citronellal and/or the overall fragrance characteristics are important.

National and international standards exist which formalise certain of these quality criteria and, if they choose to, producers can assert that their oil meets such standards while buyers can demand that what they purchase does so. For the low-volume, specialised types of oil, published standards do not exist and compliance with quality requirements is a matter between the buyer and seller.

Any prospective new producer of eucalyptus oil must be aware of the standards which exist for the type of oil he is hoping to produce. Some indication of the parameters which are quantified for the different types of oil is given below but full details should be obtained from the relevant national or international standards organisation or pharmacopoeia. Specifications are also subject to change and the current position should be checked with the same institutions. Trade and other organisations should also be able to offer advice. The addresses of many of these bodies are given in Appendix 7.

Medicinal oils

Specifications of standards organisations

The International Standardization Organization (ISO) is a worldwide federation of national standards institutes and has issued three standards covering different types of cineole-rich eucalyptus oil (ISO 1974, 1980, 1983). The standards specify those characteristics of the oils which can be quantified with a view to facilitating the assessment of their quality; they cannot adequately define those properties which involve a buyer's subjective judgement, such as odour. In many

cases the ISO standards are formally approved by member bodies of individual countries and go on to be adopted as national standards. Australia has produced its own standards for eucalyptus oil (referred to below) but other eucalyptus oil producers such as Brazil and South Africa have not.

For all three ISO standards, a minimum cineole content or range of values is specified, together with ranges of values for relative density, refractive index and optical rotation, and the solubility in ethanol. ISO 770:1980 and ISO 4732:1983 refer to steam-distilled oils from *E. globulus*. The first of these stipulates a minimum cineole content of 70 per cent while the second describes the three types of rectified oil which are commonly available from Portugal: 70/75, 75/80 and 80/85 per cent cineole. The third standard, ISO 3065:1974, specifies requirements for Australian eucalyptus oil of 80–85 per cent cineole content and defines the origin of the oil simply as ‘appropriate species of *Eucalyptus* of Australian origin’.

Standards Australia has recently published revised specifications for Australian eucalyptus oil (SA 1998). AS 2113.1-1998 lays down requirements for oil containing 70–75 per cent cineole and supersedes AS 2113-1977, while AS 2113.2-1998 refers to oil containing 80–85 per cent cineole and supersedes AS 2115-1977. Both detail physico-chemical requirements, with cineole contents in the defined ranges, as before, but the revised versions contain some additional material, including a gas chromatographic profile of the oils, a table showing the constituents and an appendix with information on flash points.

An Indian standard, IS 328:1992, exists for ‘Oil of Eucalyptus Globulus’, although the description of the oil allows it to be distilled from ‘other cineole-containing species of eucalyptus’ as well as *E. globulus* (BIS 1992). It has different ranges of values for relative density, refractive index and optical rotation to those of the analogous ISO standard and, importantly, a lower requirement for cineole: 60 per cent instead of 70 per cent.

The designations of the above standards, the minimum cineole content (or range of values) demanded by them, and the designations of the ISO standards which describe the methods of analysis to be followed, are given in [Table A5.1](#). The minimum cineole content specified in the pharmacopoeia and food specifications referred to below are also included.

Pharmacopoeia specifications

Although conveniently termed medicinal eucalyptus oils, the standards described above make no reference to the use to which the oils are put. As noted below, some cineole-rich oils are used in foods. For strictly medicinal purposes the oils must comply with national or international pharmacopoeias. Compliance with the British Pharmacopoeia (BP) specification is often cited by producers and this states that eucalyptus oil must contain not less than 70.0 per cent 1,8-cineole (BP 1998). The specification is identical to that of the European Pharmacopoeia (EP 1998). The oil is defined as being obtained from ‘various species of eucalyptus rich in 1,8-cineole’ but goes on to say that ‘the species used are *Eucalyptus globulus* Labillardière, *Eucalyptus fruticetorum* E. von Mueller (*Eucalyptus polybractea* R.T. Baker) and *Eucalyptus smithii* R.T. Baker’. In addition to giving a minimum cineole content, the specification lays down ranges for optical rotation, relative density and refractive index and states the solubility of the oil in alcohol. It also describes chemical tests which are to be carried out. These are intended to ensure that levels of aldehydes and phellandrene which might be present are below certain limits and these additional requirements distinguish the BP specification from ISO 770:1980 with which it is otherwise very similar. Several of the crude medicinal oils contain small amounts of isovaleraldehyde (see Appendix 4) and rectification serves both to increase their cineole content and to remove this undesirable constituent, thereby enabling them to meet BP standards.

Table A5.1 List of standards and specifications for cineole-rich eucalyptus oils, together with requirements for cineole content and methods for the determination of parameters referred to in the ISO standards

Type/Designation	Type of oil/Analytical method	Cineole content (%) ^a
<i>Standards</i>		
ISO 770:1980(E)	<i>E. globulus</i>	min. 70
ISO 4732:1983(E)	Rectified <i>E. globulus</i> , Portugal: 70–75%, 75–80%, 80–85%	70.0–74.9, 75.0–79.9, 80.0–85.0
ISO 3065:1974(E)	Australian, 80–85%	80–85
AS 2113.1,2-1998	Australian, 70–75%, 80–85%	70–75, 80–85
IS 328:1992	<i>E. globulus</i>	min. 60
<i>Pharmacopoeias</i>		
British	Eucalyptus oil	min. 70.0
European	Eucalyptus oil	min. 70.0
Indian	Eucalyptus oil	min. 60
Chinese	Oleum eucalypti	min. 70
<i>Food Chemicals</i>		
US	Eucalyptus oil	min. 70.0
<i>Methods</i>		
ISO 212:1973	Sampling	
ISO 356:1996	Preparation of test samples	
ISO 1202:1981	Determination of 1,8-cineole content ^b	
ISO 279:1981	Determination of relative density	
ISO 280:1976	Determination of refractive index	
ISO 592:1981	Determination of optical rotation	
ISO 7359:1985	Gas chromatography on packed columns	
ISO 7609:1985	Gas chromatography on capillary columns	
ISO 1271:1983	Determination of carbonyl value (free hydroxylamine method) ^c	

a On m/m or w/w basis.

b Measures the crystallisation temperature of a mixture of the test oil and *o*-cresol; the temperature depends on the 1,8-cineole content of the oil.

c Required for *E. citriodora* oil.

Other national pharmacopoeias that lay down standards for eucalyptus oil include those of Austria, Belgium, Brazil, the People's Republic of China, France, Germany, Hungary, India, Italy, Japan, Netherlands, Portugal and Switzerland. Although contained in the 21st (1985) edition of the United States Pharmacopoeia (16th edition National Formulary), eucalyptus oil was deleted from the 22nd/17th edition (1990) and remains absent from the 23rd/18th edition (1995). The Indian Pharmacopoeia defines eucalyptus oil in a similar way to the BP and has similar or identical values for the physico-chemical data, but, like the Indian standard referred to above (BIS 1992), it has a minimum cineole requirement of 60 per cent rather than 70 per cent (IP 1996). Like the BP it has tests for aldehydes and phellandrene.

The Pharmacopoeia of the People's Republic of China (PPRC 1992) demands a minimum cineole content of 70 per cent for eucalyptus oil but allows it to be produced from a non-eucalypt species ('by steam distillation from the plants of *Eucalyptus globulus* Labill. (Fam. Myrtaceae), *Cinnamomum camphora* (L.) Sieb. (Fam. Lauraceae) or other plants belong[ing] to the same genus of these two families'). Acceptable ranges for relative density and refractive index are given but, unlike the BP, no range for optical rotation is specified. A test for the absence of phellandrene is described and a heavy metals limit of 10 ppm is laid down.

Specifications for use in foods

Cineole-rich eucalyptus oil is sometimes used as a flavouring agent in foods and in the United States the Food Chemicals Codex (NAS 1996) lays down specifications with which it must comply. The 1996 version (4th edition) is identical to that in the 1981 3rd edition. The oil is described as being that distilled from *Eucalyptus globulus* (FEMA No. 2466) and 'other species of *Eucalyptus*' and must contain not less than 70.0 per cent cineole. In addition to specified limits for specific gravity and refractive index, the oil must pass tests that demonstrate nil (or low) amounts of heavy metals and phellandrene.

The Food Chemicals Codex also lays down specifications for eucalyptol (FEMA No. 2465), the trivial name given to the main constituent of medicinal type eucalyptus oil, 1,8-cineole (synonyms for which include cajeputol and 1,8-epoxy-*p*-menthane). An infra-red spectrum is given for identification purposes. Since eucalyptol is a single chemical, the specifications reflect its physico-chemical properties:

Molecular weight, formula	154.25, C ₁₀ H ₁₈ O
Boiling point	176°C
Specific gravity (25°C)	0.921–0.924
Refractive index (20°C)	1.455–1.460
Optical rotation	–0.5° to +0.5°
Solidification point	minimum 0°C

Perfumery oils

Of the perfumery oils, published standards exist only for *E. citriodora* oil. Other perfumery oils, such as that from *E. staigeriana*, are traded on the basis of sample assessment by the buyer.

The international standard for *E. citriodora* oil, ISO 3044:1997, sets maximum and minimum limits for relative density, refractive index and optical rotation (ISO 1997). The ranges of values for all three parameters are slightly different to those given in the previous version of the standard (ISO 3044:1974). Citronellal content is important and the oil must contain a minimum of 70 per cent carbonyl compounds expressed as citronellal to comply with the standard. In keeping with the modern trend for standards for essential oils to provide chromatographic information, ISO 3044:1997 shows typical gas chromatograms obtained on a polar and apolar column in a separate annex. A second annex provides flash point information.

An Indian standard exists for *E. citriodora* oil, IS 9257:1993. Physico-chemical data are slightly different to those given in the ISO standard but the minimum citronellal content remains 70 per cent (BIS 1993).

The Fragrance Materials Association of the United States (FMA) has a standard for *E. citriodora* oil (EOA 130) and this states that the aldehyde content, calculated as citronellal, should be in the range 65–85 per cent. Ranges of values for specific gravity, refractive index and optical rotation are also prescribed. There is also an FMA monograph for eucalyptol (1991 revision, replacing EOA 288).

Other oils

No published standards exist for oil from *E. dives* (piperitone variant) and quality criteria are a matter for agreement between buyer and seller. If the oil is being utilised as a source of piperitone then the content of the latter is usually around 40 per cent or more.

References

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- ISO (1983) *International Standard. Rectified Oil of Eucalyptus Globulus Labillardière, Portugal*, ISO 4732-1983(E), International Organization for Standardization, Geneva, Switzerland, 2 pp.
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- PPRC (1992) Oleum Eucalypti. In *Pharmacopoeia of the People's Republic of China*, English Edition, Guangdong Science & Technology Press, Guangzhou, China, p. 129.
- SA (1998) *Oil of Australian Eucalyptus. Part 1: 70–75 Percent Cineole*, AS 2113.1-1998, and *Part 2: 80–85 Percent Cineole*, AS 2113.2-1998, Standards Australia, Strathfield, Australia.