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# AUSTRALIAN AROMATIC PLANTS

## Research and Therapeutics

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PENETT BOTANICALS

Eucalyptus

Tea trees

Myrtaceae family

# OVERVIEW

- Plant families and essential oils
- Chemotypes of aromatic plants
- Essential oil chemistry
- Backhousia spp.
- Eucalyptus spp.
- Tea tree and melaleuca spp.
- Leptospermum spp. and honey
- Kunzea
- Taxandra
- Safety issues
- Clinical formulations

# ESSENTIAL OIL FAMILIES

Several plant families include representatives of the aromatic flora of Australia.

- Myrtaceae family (*Eucalyptus*, *Melaleuca* spp.)
- Rutaceae (*Boronia*, *Geijera* spp.)
- Lamiaceae (*Prostanthera*, *Mentha* spp.)
- Lauraceae (*Cinnamomum*, *Doryphora* spp.)
- Santalaceae (Sandalwood)
- Cupressaceae (Cypress)
- Winteraceae (*Tasmania* spp.)

# HYBRIDS, SUB-SPECIES AND CHEMOTYPES: EUCALYPTUS

- Despite the fact that Australia is known as the “oldest continent” the *Eucalyptus* genus has evolved relatively recently, and the vast number of sub-species and hybrids suggests the evolutionary process is still quite active. Hence any particular wild *Eucalyptus* specimen may be a true species, or maybe hybrids of two species - making correct identification a difficult matter.
- Establishing the chemical profile of an individual plant is even more complex, since various “chemotypes” exist for some species of *Eucalyptus* and of the Myrtaceae family generally. Each chemotype is genetically determined and physical features and locality are not accurate indicators. The only reliable method is to submit the leaves to chemical analysis, the most common method being GC/MS = gas chromatography coupled with a mass spectrometer.

**Table: Examples of Eucalyptus chemotypes**

Species	c/type 1	c/type 2
<i>E. dives</i>	52% pipertone	70-80% cineole
<i>E. radiata</i>	65-70% cineole	18% phellandrene 12% piperitone

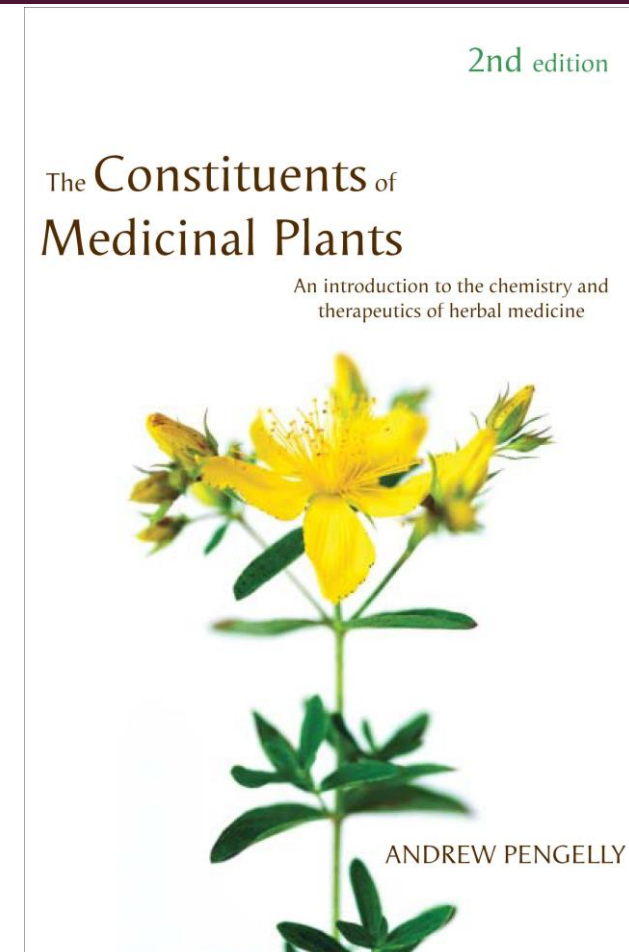
# TEA TREE CHEMOTYPES

- CT I: terpinen-4-ol,  $\alpha$ -thujene,  $\alpha$ -terpinene,  $\gamma$ -terpinene
- CT I I: 1,8-cineole,  $\alpha$ -pinene,  $\beta$ -pinene, myrcene, limonene,  $\alpha$ -terpineol
- CT I I I:  $\alpha$ - phellandrene, terpinolene, linalool.
  - Keszei, Hassan & Foley, 2010.
- The Australian standard for any oil traded under that name contains less than 15% cineole and over 30% terpinen-4-ol (ie CT I).
- For anyone intent on establishing a tea tree oil plantation, it is paramount the propagation material used is derived from plants with the right chemotype.

# ESSENTIAL OIL CHEMISTRY

## Classification Of Essential Oil Compounds

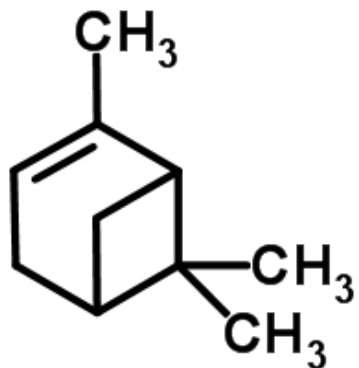
Compound	Description	Example	Properties
Hydrocarbon	Contain only carbon and hydrogen atoms.	Pinene; terpinene; p-cymene	Stimulant, decongestant, antiviral, antitumour
Alcohol	Contains a hydroxyl group (OH) attached to the terpene structure.	Menthol; terpenin-4-ol; linalool; geraniol; nerolidol	Antimicrobial, antiseptic, tonifying, spasmolytic
Aldehyde	Terpenoids with a carbonyl group (C=O) and hydrogen bonded to a carbon.	Citral (geranial/neral); citronellal	Spasmolytic, sedative, antiviral
Cyclic aldehydes	Aldehyde group attached to a benzene ring	Cinnamic aldehyde; vanillin	Spasmolytic
Ketone	Contains a carbonyl group bonded to two carbon atoms.	Camphor; piperitone	Mucolytic, cell-regenerating, neurotoxic
Phenol	Hydroxyl group attached to a benzene ring	Thymol; eugenol; carvacrol	Antimicrobial, irritant, immune stimulating
Phenolic ether	Contains an O between C and benzene ring	Safrol; elemicin; myristicin	Carminative, spasmolytic
Oxide	Has an O bridging 2 or more carbons	1,8-cineole; ascaridole	Expectorant, stimulant
Ester	Condensation product of acid and alcohol	Methyl salicylate; allyl isothiocyanate	Spasmolytic, sedative, antifungal



2004, Allen & Unwin

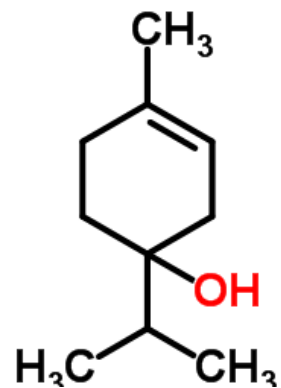
# CHEMICAL STRUCTURES - MONOTERPENES

## Hydrocarbons



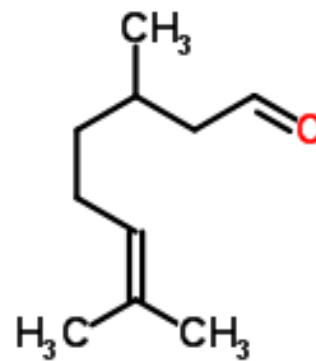
$\alpha$ -pinene

## Alcohols



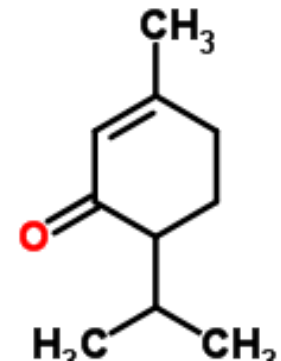
terpinen-4-ol

## Aldehydes



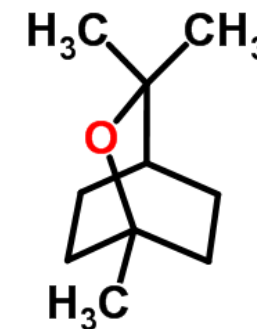
citronellal

## Ketones



piperitone

## Oxides



1,8-cineole

# BACKHOUSIA

- *Backhousia* is a genus of eight species of small to medium sized trees endemic to moist forests of eastern Australia. Each species has a distinctive aroma and corresponding essential oil profile in the leaves.
- At least three species are undergoing commercial cultivation as flavouring agents for the burgeoning “bush food” industry as well as for medicinal use.
- The main species used in clinical practice is *B. citriodora*



# BACKHOUSIA SPECIES AND CONSTITUENTS

## Species

*B. citriodora*  
*B. myrtifolia*  
*B. anisata*  
(syn. *Anetholea anisata*)  
*B. angustifolia*  
*B. bancroftii*  
*B. hughesii*  
*B. kingii*  
*B. sciadophora*

## Primary compounds

aldehyde - citral  
phenolic ethers - emelicin, methyl eugenol  
phenolic ethers - anethole, methyl chavicol  
triketones - angustione  
alkyl acetates  
sesquiterpenes - bisabolene  
hydrocarbons - pinene, limonene  
hydrocarbons - pinene, limonene

- Ref. Brophy, Goldsack, Fookes & Forster, 1995

## LEMON MYRTLE: *Backhousia citriodora*

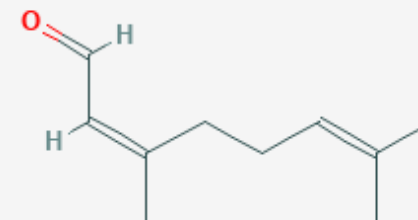
*B. citriodora*, known as lemon-scented myrtle and lemon ironwood is a sub-tropical tree, it's distributed restricted to SE Queensland - particularly in the Eumundi-Gympie area. However it is widely cultivated across Eastern Australia

It is a tall evergreen with dense foliage, and covered by terminal clusters of white staminate flowers during summer



# AROMATIC CHEMICAL PROFILE

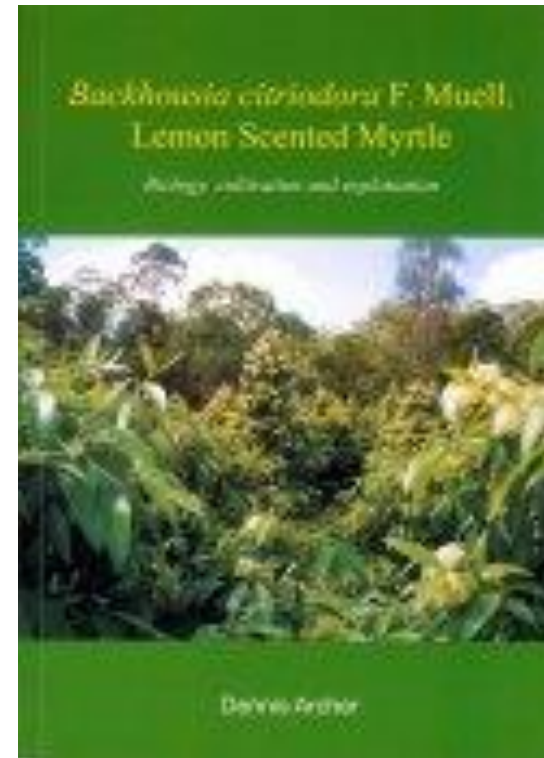
- The oil of this species is composed almost entirely of the monoterpenoid aldehyde citral (Brophy et al. 1995).
- Citral is an isomeric blend of geranial and neral
- Trace components include linalool, citronellal, methyl heptenone
- Australian standard: minimum 85% citral
- A rare chemotype (Variety A) high in citronellal is known (Archer, 2004)
  
- Since the 1920s *B. citriodora* essential oil has been recognized as producing high quality citral for production of lemon flavouring beverages (Southwell et al, 2000; Williams, 2010).
- No grassy notes to the lemon aroma as compared with lemongrass.
  
- Properties of citral:
  - Antimicrobial and sedative, possible antitumor
  - a useful agent in viral, bacterial and fungal infections
  - Oral intake of citral provides protection from insect bites (Saito, Sohei, Koltunow, & Sakai 2011)



neral (cis-citral)

# EXTRACTION METHODS

- Steam distillation
  - Avge.Yield 1.5% w/w
- Ethanol extraction
- Aqueous ethanol extraction
  - eg 1:5 tincture in 45% etoh
- Aqueous infusion
  - eg. 1:20 infusion in hot water



# CLINICAL AND EXPERIMENTAL RESEARCH

- *B. citriodora* essential oil and a leaf paste were found to inhibit growth of bacteria and fungi, including human pathogens *Clostridium*, *Pseudomonas* and a hospital isolate of methicillin resistant *S. aureus* (MRSA). Interestingly, the essential oil was more potent than citral alone (Wilkinson et al, 2003).
- Antimicrobial effects compares favourably with tea-tree oil (Hayes & Markovich 2002) – see table
- Methanolic extracts demonstrated potent antibacterial and antifungal effects using a disc diffusion and growth time course assay (Cock, 2013)
- Viral infections have been treated also. In a small clinical study, Burke and co-workers demonstrated a 90% reduction of lesions in children infected with *Molluscum contagiosum* using a 10% olive oil solution of *B. citriodora* essential oil, compared with no reduction in lesions in the control group (Burke, Baillie & Olsen, 2004).
- In Japan Hirobe and co-workers demonstrated antiviral effects for *B. citriodora* leaf capsules against HIV and Cytomegalovirus (Archer, 2004).
- Lemon myrtle infusion was found to have antioxidant effects comparable to *Camellia sinensis*, and more potent than other herb teas tested., on the basis of total phenolic content, ascorbic acid equivalent antioxidant capacity, ferric-reducing power, and chelating EC50 (Chan, Lim, Chong, Tan & Wong 2010)

# MIC VALUES (AS %,V/V) FOR LEMON MYRTLE OIL AND TEA TREE OIL

Organisms	Lemon myrtle oil	Tea tree oil	Citral
■ S. aureus	0.05	0.2	0.03
■ E. coli	0.03	0.2	0.03
■ P. aeruginosa	2.0	>2.0	2.0
■ C. albicans	0.03	0.2	0.03
■ A. niger	0.1	0.4	0.1
■ MRSA	0.2	0.3	0.2
■ K. pneumoniae	0.2	0.3	0.2

# THERAPEUTIC APPLICATIONS

- In aromatherapy
  - Described as a rich, uplifting, refreshing lemony aroma (Trevena, 2016)
  - Common cold, influenza, bronchitis, chest congestion
  - Dyspepsia
  - Herpes and other viral skin lesions
  - Cuts, insect bites, acne, tinea
  - Aids concentration, uplifting, antidepressant, promotes sleep
  - Surface disinfectant
- In herbal medicine
  - Similar too above
  - Antioxidant
  - Taste corrective
  - Note: *B. citriodora* leaf and leaf oil classified as “Listed” medicines by TGA (2003)





# METHODS OF ADMINISTRATION

- Aromatherapy
  - Diffuser, oil burners
  - Inhalant
  - Bath oil
  - Hydrosol
  - Topical applications – dilute 1-10% in base oil or cream
    - CMEC (2000) recommends concentrations not exceeding 1%
  - Antimicrobial blend: teatree/lemon myrtle oil 4:1
    - Increases antimicrobial effect of teatree oil and reduces sensitization of lemon myrtle (Hayes & Markovich 2002)
  - Insect repellent blend: *Melaleuca ericifolia* /lemon myrtle oil 4:1 (Grieve et al. 2010).
- Herbal medicine
  - Tincture, 1-2mL in water, 2-3 times daily
  - Infusion, one cup 2-3 times daily
  - Lemon myrtle can also be made into a refreshing iced beverage or lemonade
  - Dried leaves applied as mosquito repellent



<http://www.nativetastes.com.au/products.htm>



# SAFETY ISSUES

- Aldehydes such as citral are potential skin sensitizers or irritants
- Essential oil not to be applied undiluted
- In vitro cytotoxicity testing indicated that both lemon myrtle oil and citral had a very toxic effect against human cell lines. However a product containing 1% essential oil was found to be non-toxic (Hayes & Markovich 2002)
- Ethanolic extract exhibited low toxicity in a modified *Artemia franciscana* nauplii lethality assay (Cock, 2013)
- According to the *Essential Oil Safety* guide *B. citriodora* oil deemed to have only a slight risk of sensitization (Tisserand & Balacs, 1995)
- Patch testing
- Citral-containing oils are contraindicated in patients with glaucoma (Tisserand & Balacs 1995)

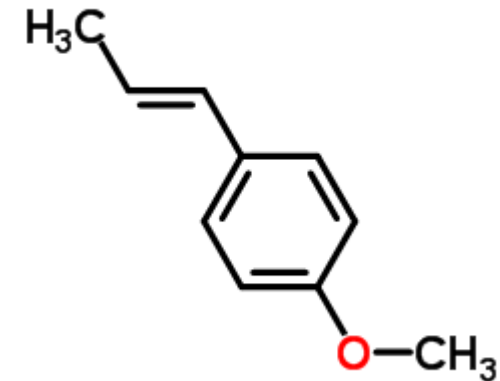
## ANISEED MYRTLE *Anetholea anisata* (*Backhousia anisata*)



- A tall rainforest tree with bright green foliage
- Leaves have distinct aniseed odour
- Creamy-white flowers occur in the early summer
- The tree has a limited geographical distribution, centered around the Bellingen Valley, NSW where it grows in subtropical rainforest, often along streams or on lower slopes
- As a popular “bushfood”, plantations of the aniseed myrtle have been established to meet the demand.
- It is designated as a Threatened Species (NSW flora online)
- Note: This species has been reclassified as *Syzygium anisatum* in some publications

# CHEMICAL CONSTITUENTS

- Essential oil
  - Phenolic ethers: trans-anethole, methyl chavicol (estragole)
  - Note: trans-anethole is similarly a major component in aniseed, star anise and fennel essential oils
    - methyl chavicol is a major component of sweet basil essential oil (Webb, 2000)
  - Similar to *B. citriodora* and citral, *A. anista* is an excellent source for commercial production of E-anethole for aniseed flavor (Blewett & Southwell, 2000).
- Flavonoids
  - Myricetin, hesperetin glycosides (Konczak et al. 2010)



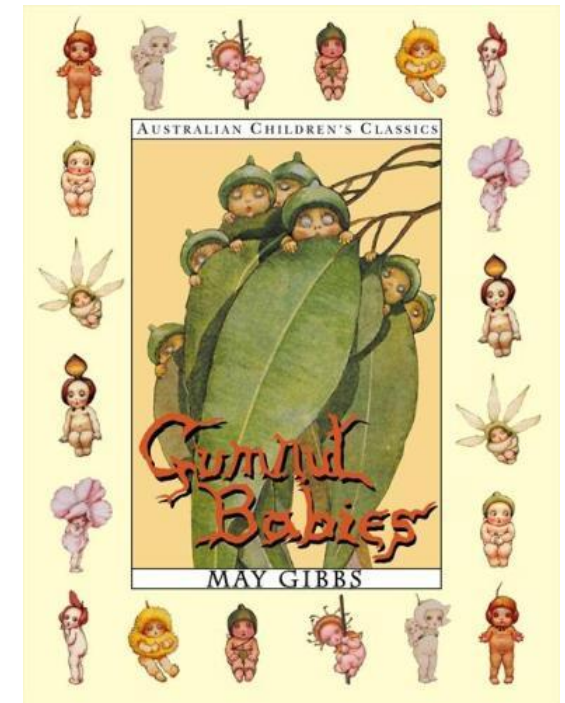
trans-anethole (syn. E-anethole)

# PROPERTIES

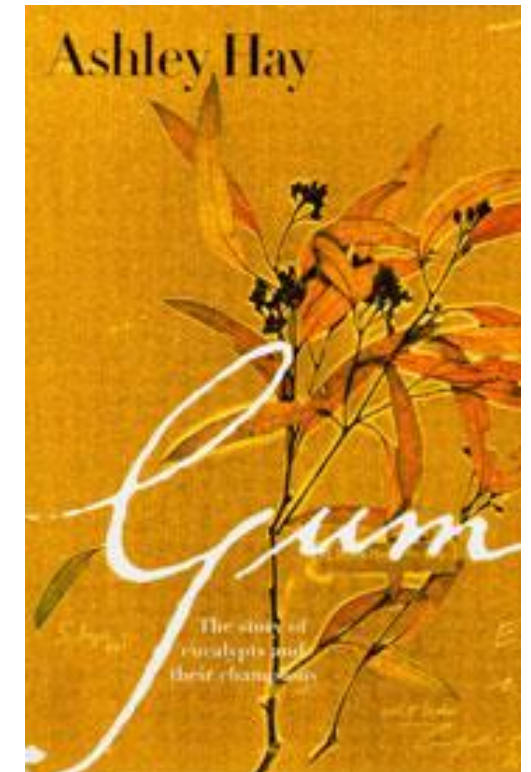
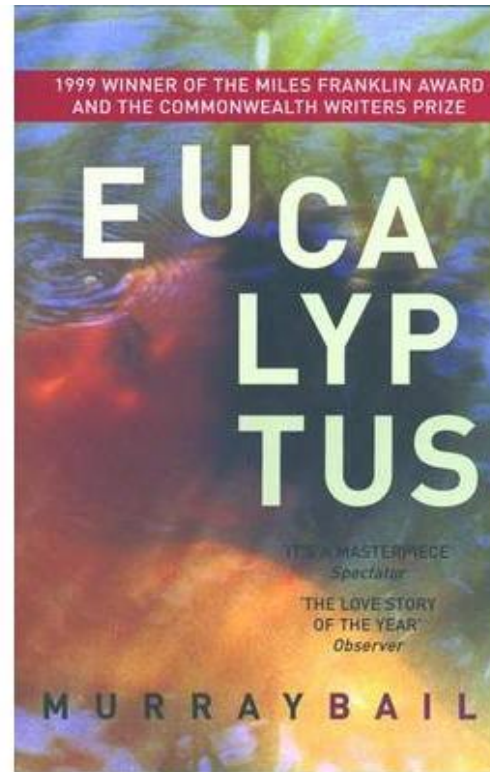
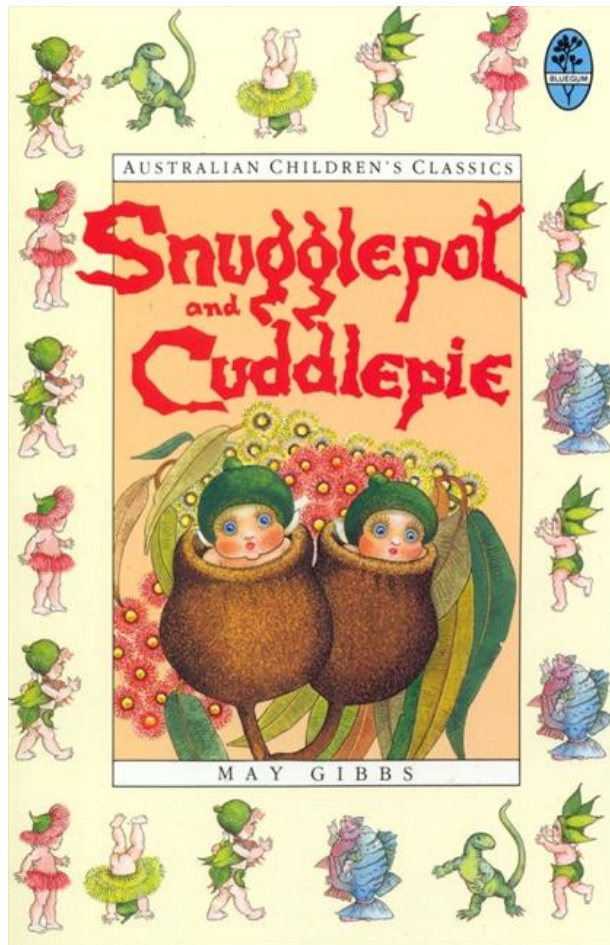
- Used as a flavoring for its aniseed/licorice – like flavor
- Described as particularly fresh, a richer more appealing oil than other aniseeds (Trevena, 2016)
- Similar therapeutic benefits as to other anethole-containing herbs
  - Carminative for stomach upsets, dyspepsia, colic
  - Relieves anxiety, stress, calming and sedating
  - Mildly estrogenic, promotes lactation
  - Weight loss
  - Antioxidant
- Methyl chavicol (estragole) is spasmolytic and anticonvulsant
  - Possible carcinogen in high doses
  - Mild narcotic in high doses
- Externally may be a dermal irritant in sensitive subjects

# EUCALYPTUS

- **Eucalypts - gums**
- This is a genus over well over 600 species and even more sub-species and varieties.
- Recently in excess of 100 species were reclassified from the *Eucalyptus* to a new genus named *Corymbia*, hence *E. citriodora* is now officially *Corymbia citriodora*.
- “Eucalypt” group:
  - *Eucalyptus* spp.
  - *Corymbia* spp.
  - *Angophora* spp.



# EUCALYPTUS AND LITERATURE





# ABORIGINAL USES OF EUCALYPTS

- infusions of leaves to relieve colds
- inhaling steam of heated leaves for headaches
- poultices made of bruised and heated leaves for aches and pains. Leaves may be burned in a pit, the patient lying over the steaming mass to relieve backache and rheumatism.
- sticky gum (kino) exudate from Eucalypt trees applied to cuts. Hard lumps are soaked in water to soften, so that it sticks to the skin and dries to form a protective film over the lesion.



Kino exudate from *Corymbia calophylla* (marri, WA)

## IN WESTERN HERBALISM

- *Eucalypt* leaves may be taken as infusions, inhalations, and made into tinctures.
- Apart from essential oils their leaves are rich in other compounds including tannins and triterpenes, while some species contain high levels of rutin.
- *E. globulus* is the preferred species for oil production because of its high cineole content (cineole being the main expectorant and decongestant component of Eucalyptus oil), however some of the secondary constituents that are reduced or eliminated by repeated distillations are also of value – especially the terpenes and alcohols, whose antimicrobial actions reinforce the mucolytic action of cineole.
- The secondary constituents also endow the oils with a more gentle reaction when applied to skin and mucous membranes.



# EUCALYPTUS OIL PROFILES

Genus	Species	Common name	Major constituent	Minor constituents
<i>Eucalyptus</i>	<i>globulus</i>	Tasmanian blue gum	1,8-cineole	a-pinene
	<i>radiata</i>	narrow leaf peppermint	1,8-cineole	a-terpineol citral
	<i>divers</i>	broad leaf peppermint	piperitone	phellandrene
	<i>polybractea</i>	blue mallee	1,8-cineole	p-cymene
	<i>stageriana</i>	lemon ironbark	citral	phellandrene
	<i>melliodora</i>	yellow box	1,8-cineole	a-pinene
<i>Corymbia</i>	<i>citriodora</i>	lemon scented gum	citronallal	citronellol



# EUCALYPTUS GLOBULUS

- Tasmanian blue gum
- Provides most of the highly refined Eucalyptus oil used in global commerce.
- Non volatile constituents include triterpenes, ellagitannins, coumarins, flavonoids.
- The actions are expectorant, rubefacient, antiseptic, antiviral, astringent, stimulant.
- It is used, often in the form of an applied or inhaled oil, to treat bronchitis, influenza, common cold, asthma, sinusitis, laryngitis, arthritis.
- External applications relieve muscular and rheumatic pains. A 1:5 tincture can be made with crushed dried leaves. The dose is 1-4mL.
- Oil distilled from *E. globulus* fruits have more potent antibacterial activity compared to the leaf oil. The constituent responsible is aromadendrene (Mulyaningsih et al. 2011.)
- *E. globulus* oil is not widely produced in Australia, the majority coming from China
  - <http://eopaa.com.au/essential-oil-industry-australia/>



# EUCALYPTUS DIVES

- The broad-leaf peppermint, is common across much of south-eastern New South Wales and Victoria.
- This tree yields a high level of essential oils in its leaves (up to 4%), the main constituent being the ketone piperitone giving a fresh peppermint-like Eucalyptus aroma.
- Another chemotype *E. dives* var. C contains 70% cineole, terpineol and citral, making it one of the most sought after of the Eucalyptus oils.
- Yet another chemotype contains the fragrant phellandrene as its main constituent.
- The first 2 chemotypes are good for lower respiratory tract infections such as bronchitis, and may have mild broncho-dilating effects (Webb, 2000).
- Inhalations are beneficial for unproductive coughs, colds and respiratory tract infections



[https://en.wikipedia.org/wiki/Eucalyptus\\_dives](https://en.wikipedia.org/wiki/Eucalyptus_dives)

## *E. RADIATA, E. AUSTRALIANA*

- The narrow-leaf peppermint, has a similar geographic range to *E. dives*.
- It has several chemotypes, hence the oil composition between individual trees can vary considerably.
- One chemotype, often referred to as *E. Australiana* or var. *Australiana*, contains 65-72% cineole,  $\alpha$ -terpineol,  $\alpha$ -pinene, geraniol and citral.
- The latter constituents impart a refreshing aroma to the oil. It is described as fresh, fruity, probably the most pleasant, child friendly Eucalyptus (Trevena, 2016)
- Research shows it to be a potent antiviral, inhibiting both herpes and influenza viruses, while its gentle action reflects the harmonious balance of constituents.
- This oil has been used with great success for topical treatment of cold sores and shingles. Application of the oil diluted with vegetable oil has been found to help prevent the progression of colds and flu if applied in the early stages.
- A high cineole variety was shown to inhibit gram positive multi-drug resistant pathogens (Mulyaningsih et al. 2011).



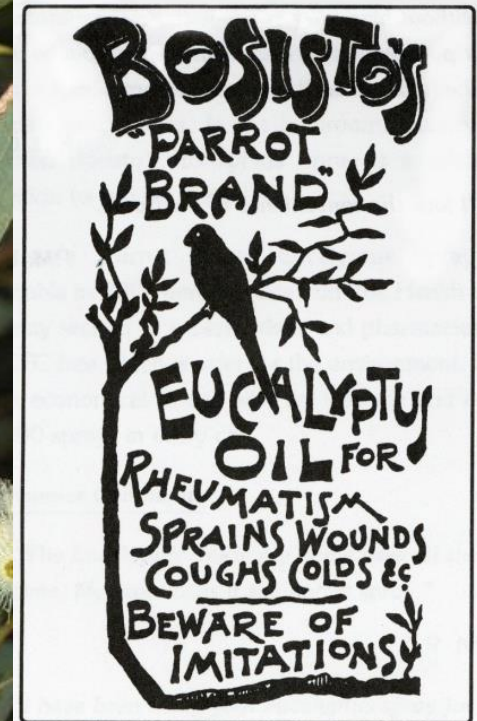
<http://www.downunderenterprises.com/Shop/E-K>





## *E. POLYBRACTEA*, BLUE MALLEE

- Small multi-trunked tree, limited distribution in western NSW and Victoria.
- Essential oil - naturally very high in 1,8-cineole
- Described as very medicinal, clinical eucalypt aroma (Trevena 2016)
- The major species used in commercial production in Australia



# CORYMBIA CITRIODORA – LEMON-SCENTED GUM

- A tall forest tree found in coastal and sub-coastal regions of Queensland, and is widely cultivated in the southern states for ornamental purposes.
- Essential oil
  - Monoterpenes citronellal, citronellol, citriodoral and esters
  - Sesquiterpene guaiazulene, similar to chamazulene from chamomile
- Other constituents
  - ellagitannins, flavonoids (kaempferol, myrtillin) and organic acids
- Described as a strong, fresh, crisp, invigorating lemon aroma with a touch of Eucalyptus (Trevena 2016)
- Actions: antibacterial, anti-inflammatory, spasmolytic, sedative, antiviral, antifungal, hypoglycaemic, insecticide.
- Indications: viral and bacterial infections, candida infections, dyspepsia, colic, mature onset diabetes, rheumatoid arthritis, nervous irritability.
- Externally it is used for *Herpes* lesions and applied to the skin as an insect repellent. It may be used as a simple infusion or a 1:5 tincture from crushed dried leaves, with a dose of 1-4mls.
- Guaiazulene protects against paracetamol toxicity in rats through antioxidant mechanism (Kourounakis et al, 1997. *J Pharm and Pharmacol* 49.)



*C. citriodora*. Photo by A. Pengelly

# EUCALYPTUS STAGERIANA – LEMON IRONBARK

- Constituents
  - Essential oil
    - Citral 30%, limonene, b-phellandrene, geraniol, a-citral, geranyl acetate, methyl generate
    - Main production: Brazil, Guatamala, Australia
  - Described as a sweet fresh lemon Eucalyptus aroma
  - Actions - antibacterial, decongestant, expectorant, antiviral
  - Leaf used as bushfood spice or herb tea
    - Williams, C.J. 2010 *Medicinal Plants in Australia*.Vol. 1



[https://en.wikipedia.org/wiki/Eucalyptus\\_staigeriana](https://en.wikipedia.org/wiki/Eucalyptus_staigeriana)



# EUCALYPTUS OIL SAFETY

- Cineole-rich Eucalyptus oils can cause CNS and breathing problems in young children.
- Avoid using on or near the face of children under 10. Their dermal maximum recommendation is 20%
  - Tisserand & Young, 2014
- The oral acute toxicity of 1,8-cineole in rats is over 2000 mg/kg
  - El-Fadel 2013.
- Many common constituents of essential oils including 1,8-cineole have been categorized by European authorities as skin sensitizers.
  - Dornic et al, 2016.



# LEPTOSPERMUM

The first European settlers developed a liking for a tea made from the aromatic leaves of various *Leptospermum* species, hence the name tea-tree (not to be confused with the separate but related genus *Melaleuca* from which tea tree oil is derived).

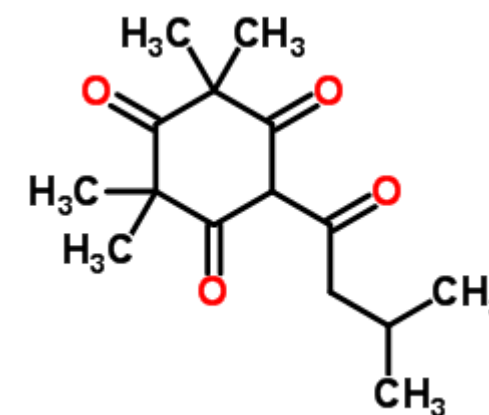
There are 79 species of *Leptospermum*, all but two are native to Australia. Two species, *L. petersonii* and *L. liversidgei*, are strongly lemon scented.

The New Zealand tea tree *L. scoparium* is a traditional Maori herb, known in that country as manuka. It is regarded as a virtual panacea in New Zealand, and pharmacological studies have confirmed the oil is a potent antifungal and antimicrobial. Manuka oil is the basis for various lotions and mouthwashes, indicated for mouth ulcers, gum disease, cuts, wounds and tinea.

This species is also found in Australia, though the most familiar forms are the ornamental hybrids with large flowers and stunted growth.

# LEPTOSPERMUM ESSENTIAL OIL PROFILES

Species	Common name	Major constituent	Minor constituents
<i>L. petersonii</i>	lemon-scented tea tree	citral	citronellal
<i>L. scoparium</i>	New Zealand tea tree; manuka	leptospermone	triterpene acids
<i>L. polygalifolium</i>	tantoon	eudesmol	pinene; terpenin-4-ol
<i>L. liversidgeii</i>	“mozzie blocker”	citronellal	citral (chemotype)



leptospermone

## *L. PETERSONII* – LEMON-SCENTED TEA TREE

- *L. petersonii* (syn. *L. citratum*) is an evergreen native to Northern NSW and SE Queensland. It is readily cultivated in southern states
- The oil of *L. petersonii* is composed of the aldehydes citral and citronellal as well as ketones.
- Brophy et al (2000) identified 5 chemotypes
- The actions are antiseptic, antimicrobial, carminative and sedative.
- It is made into a tea for treatment of coughs and colds, fungal and bacterial infections, nervous irritability and dyspepsia.



# COMPARISONS - LEMON SCENTED MYRTLES

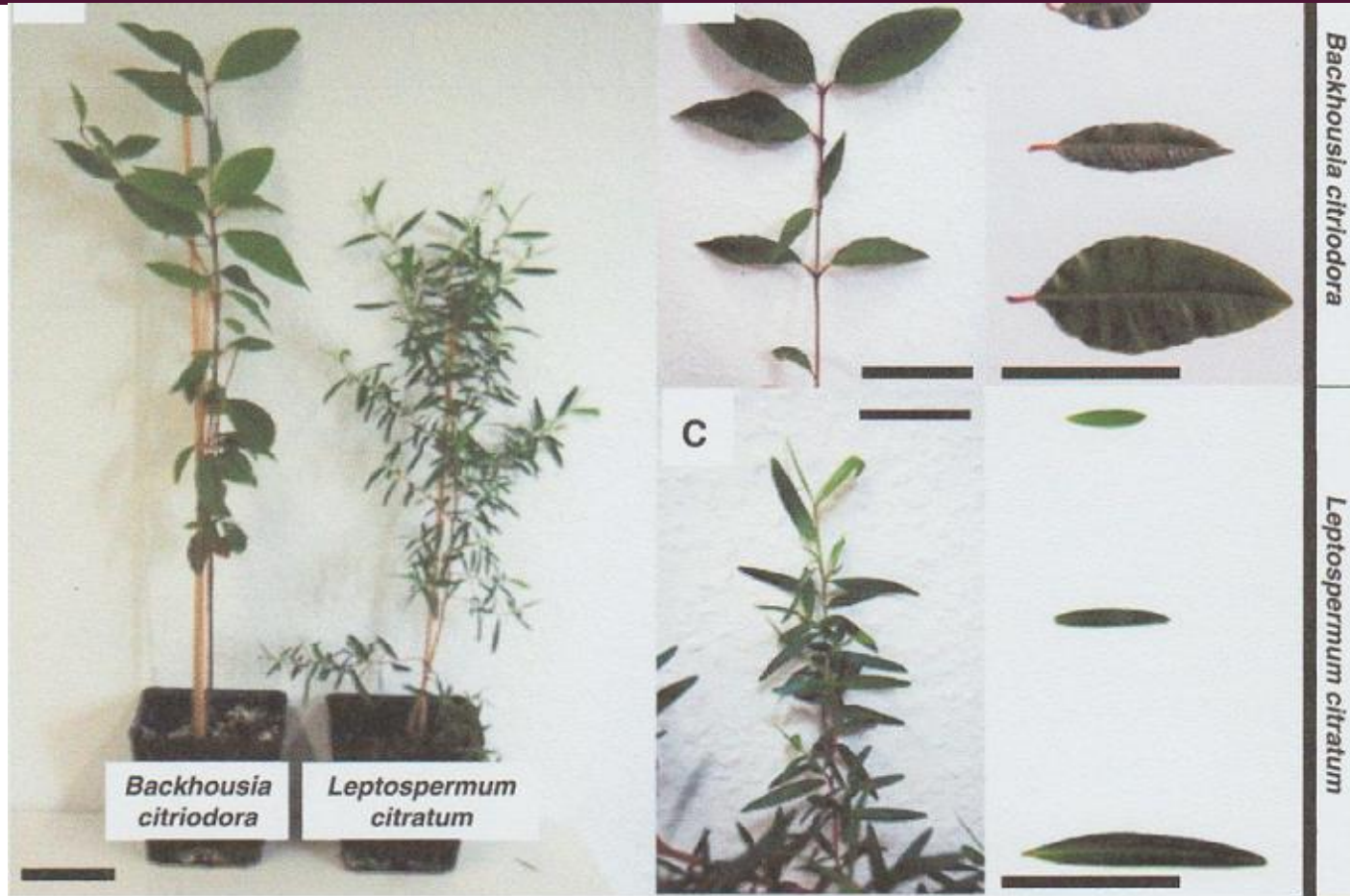


Image from Horn et al. 2012. Molecular diagnostics of lemon myrtle.

# ESSENTIAL OIL CHEMISTRY

- The following table shows the typical range of *L. petersonii* essential oil monoterpenoid constituents, according to the analysis conducted by Brophy and co-workers, 2000. Note the variation between the 5 chemotypes.

Constituent	CT 1	CT2	CT3	CT4	CT5
Neral	31.3	13.5		0.5	
Geranial	45.4	22.8		0.3	
Citronellal	6.8	46.2			
$\beta$ -Terpineol	31.3	13.5		0.5	
Nerol	0.7	0.2			38.3
Geraniol	2.7	2.4	4.8		21.2
Terpinolene				17.6	7.3
$\alpha$ -Pinene	12.3	0.1	0.1	9.6	0.6
Terpinene				26.5	11.5

CT1 – common lemon-scented form (“type”)

CT2 – citronella type

CT3 - sesquiterpene type

CT4 – terpinene/cajuput type

CT5 – rose-scented type

# ANTIMICROBIAL PROPERTIES

Maximum Inhibitory Concentrations (MIC) of *L. petersonii* essential oils (Neville-Jones & Hallam 1999)

Organism	MIC
<i>Aspergillus niger</i>	0.36% w/w
<i>Pseudomonas aeruginosa</i>	>2.38% w/w
<i>Candida albicans</i>	0.21% w/w

In a separate study, *L. petersonii* eo. (CTI) produced 100% inhibition of 3 species of *Aspergillus*, while several species of *Eucalyptus* and *Melaleuca* provided little or no inhibition. The most active constituents were neral and geranial (Kim & Park, 2012).

In vivo study: Animals with aspergillosis disease induced by exposure to *Aspergillus fumigatus* L. were treated with oil. Animals that completed the treatment had no trace of fungal infection, and no adverse effects were observed.

Conclusions: The significant reduction in fungal burden in the lungs of infected animals by the volatiles of *L. petersonii* oil was larger than that reported for conventional antifungal drugs of choice (Hood, Burton, Wilkinson & Cavanagh 2010).

# THERAPEUTIC APPLICATIONS

- **Actions**

- Antimicrobial, expectorant, anti-inflammatory, digestive stimulant, taste corrective
- Antifungal activity against dermatophytes: *Microsporum*, *Trichophyton*, *Epidermophyton* (Williams, 2011)

- **Indications** (Santich, 2001)

- Respiratory infections, chest congestion
- Digestive disturbances characterized by spasm and pain
- As an excellent addition to antimicrobial creams and wound-healing salves
- As an inhalant for upper respiratory congestion
- Insect repellent

- **Hydrosol**

- As an oral throat spray
- Disinfectant mouth wash
- Facial spray
- Surface cleaning agent and disinfectant
- For management of skin problems in pets

- **Note:**

- Generally lemon-scented tea tree essential oil as well as the crude herb are prepared and used in a similar way as the lemon myrtle (*Backhousia citriodora*).

# BLENDING ESSENTIAL OILS

- Blends well with citrus oils and with wood oils such as sandalwood, cypress
- Used to improve the scent of more medicinal oils with overlapping actions eg tea tree, eucalyptus oils
- Combines well with other herbs in respiratory blends (Webb, 2000).
  
- For antimicrobial creams, combine with tea tree oil, propolis and Calendula
- For decongestant rubs combine with essential oils of *Eucalyptus* and *Melaleuca ericifolia*
- To enhance the antimicrobial action of Calendula infused oil (Santich 2001)
  
- Use sparingly, so as not to overpower other aromas (Trevena, 2016)



## SAFETY ISSUES – *L. PETERSONII*

- As noted for *B. citriodora*, aldehydes such as citral are potential skin sensitizers or irritant
- Similar concerns apply to *L. petersonii* oil eg the essential oil not to be applied undiluted
  - Patch test
- Citral-containing oils are contraindicated in patients with glaucoma (Tisserand & Balacs 1995)

# L. POLYGALIFOLIUM – TANTOON, JELLYBUSH

- The original tea tree found at Port Jackson, used by early settlers for making tea
- Previously known as *L. flavescens*

**Essential oil profile variation in subspecies** (Brophy et al. 2000)

<i>L. polygalifolium</i> subspecies	Essential oil components
<i>polygalifolium</i>	$\alpha$ -, $\beta$ - pinene
<i>montanum</i>	$\alpha$ -, $\beta$ , and $\gamma$ -eudesmol.
<i>howense</i>	
<i>cismontanum</i>	1,8 cineole
<i>transmontanum</i>	$\alpha$ - pinene
<i>tropicum</i>	spathulenol
<i>wallum</i>	



<https://www.flickr.com/photos/31031835@N08/6273629928/in/photostream/>

Brazilian cultivated plants recorded high levels of the sesquiterpene nerolidol (Demuner et al, 2011)

# LEPTOSPERMUM HONEY

- Manuka honey
  - *Leptospermum scoparium*
- Kanuka honey
  - *Kunzea ericoides*
- Jellybush honey
  - *L. polygalifolium*
- New Zealand Medihoney
  - Combination of manuka and kanuka
- Australian Medihoney
  - combination of manuka and jellybush

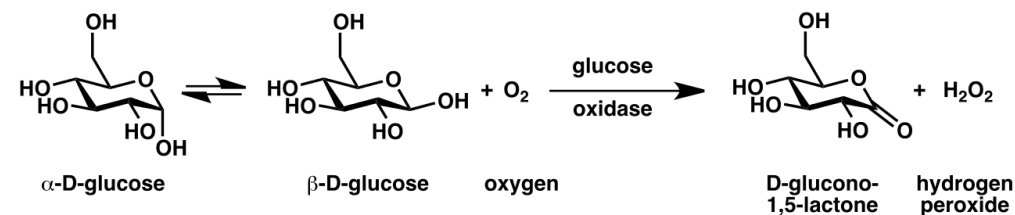


Wound healing case studies from St. Vincent Hospital, Sydney.

<http://outside-us.dermasciences.com/medihoney>

# ANTIMICROBIAL CONSTITUENTS OF HONEY

- Hydrogen peroxide  $H_2O_2$  – product of glucose breakdown by glucose oxidase
  - May be neutralized by catalase from flower pollen
- Osmotic pressure
- Low pH (3.5-4.5)
- Phytochemicals
  - Polyphenols
  - Peptide – bee defencin I
  - Methylglyoxal (MGO)
  - Methyl syringate
- Phytochemical induced antimicrobial activity is known as non-peroxide activity (NPA)
  - Still active in presence of catalase
    - Carter et al. (2016)



[https://commons.wikimedia.org/wiki/File:Glucose\\_oxidase\\_rxn.svg](https://commons.wikimedia.org/wiki/File:Glucose_oxidase_rxn.svg)

# LEPTOSPERMUM HONEY ANTIMICROBIAL

- To date, in vitro assays have found manuka honey can effectively inhibit all pathogenic bacteria tested
- Clinical isolates with multiple drug resistance (MDR) phenotypes have no reduction in their sensitivity to honey, indicating a broad spectrum of action that is unlike any known antimicrobial
- Absence of bacterial resistance has been demonstrated in medical-grade manuka honey (Cooper et al, 2010)
- Resistant strains of *Staphylococcus aureus* and other species depend on biofilm formation for protection from antibiotics. Honey can penetrate biofilms and reduce the viability of these strains. MGO appears to be the main component of honey responsible for this effect. (Carter et al. 2016)
- Synergy between oxacillin and manuka honey sensitizes methicillin-resistant *Staphylococcus aureus* to oxacillin. (Jenkins & Cooper, 2012a).
- Improving Antibiotic Activity against Wound Pathogens with Manuka Honey In Vitro (Jenkins & Cooper, 2012b).
  
- Survey of Australian honey flora based on UMF values – *L. polygalifolium* honey has equivalent antimicrobial power to Manuka honey.
- Stability studies indicate this activity increases with storage (Irish, Blair & Carter, 2011).

# MELALEUCA - PAPERBARKS

- Melaleucas are sometimes referred to as tea tree (tea tree oil), but are more correctly named paperbarks.
- Approximately 300 spp, (if Callistemons are included)
- Located mainly in Australia, also SE Asia and Pacific Islands
- Essential oil profiles: Brophy
  - Craven & Doran, 2013



## SELECTED SPECIES AND CONSTITUENTS

Melaleuca	alternifolia	tea tree	terpenin-4-ol >30%	cineole <15%
	linariifolia	snow in summer	terpinen-4-ol >30%	Cineole <15%
	ericifolia	'rosalina'	linalool	1,8 cineole
	cajuputi	cajuput tree	1,8-cineole	$\alpha$ -terpineol
	quinquenervia	coastal paperbark 'nerolina' 'niaouli'	linalool 1,8-cineole	nerolidol limonene
	bracteata	black tea tree	CT III. E-methyl isoeugenol	isoeugenol
	teretifolia	honey myrtle	CT II. neral	geranial
	fascicularis	Clustered scent- myrtle	geraniol 75%	geranyl acetate



# MELALEUCA ALTERNIFOLIA

- One of the top selling essential oils in the world
- Main world production, N-E NSW Australia – area of natural distribution
- Chemotypes:
  - CT 1: terpinen-4-ol 30-40%;  $\alpha$  and  $\gamma$ - terpinene
  - CT 2: 1,8-cineole 25-90%
  - CT 3: terpinolene 40-55%
- Aromatherapy: odour described as fresh, sharp, “reassuring medicinal” (Trevena, 2016)
- Therapeutics:
  - “The first aid kit in a bottle”
  - Clinically proven for treatment of acne, fungal infections



# TEA TREE OIL RESEARCH UPDATE

- Contact allergy and chemical composition.
  - Anton C. de Groot and Erich Schmidt. 2016. *Contact Dermatitis*
- Acne - mild to moderate. A phase II pilot study using tea tree gel and face wash
  - Provided significant improvement and well tolerated
    - Malhi et al. 2016. *Aust J Dermatol.*
- Scabies – review of TTO as adjuvant topical medication
  - Thomas et al. 2016. *Am J Trop Med Hyg.*
- Staph aureus growth and endotoxin
  - Inhibited  $\alpha$ -hemolysin (virulence factor) and enterotoxins in vitro
  - ELISA demonstrated suppression of TNF- $\alpha$  production in cells activated by staph enterotoxin
    - Ce Shia et al. 2016. *Food Control* 62
- Antimicrobial effect enhanced by encapsulation as nanoparticles in liposomes (LTTOs)
  - Yan Ge & Mingqiao Ge 2016. *J Exper Nanoscience* 11



[https://commons.wikimedia.org/wiki/File:Tea\\_tree\\_plant.jpg](https://commons.wikimedia.org/wiki/File:Tea_tree_plant.jpg)

# ANTIVIRAL TEA TREE OIL – SYNERGISM

Akram Astani, Jürgen Reichling and Paul Schnitzler (2010). Comparative Study on the Antiviral Activity of Selected Monoterpenes Derived from Essential Oils. *Phytotherapy Res.* 24, 673–679.

Essential oils are complex natural mixtures, their main constituents, e.g. terpenes and phenylpropanoids, being responsible for their biological properties. Essential oils from eucalyptus, tea tree and thyme and their major monoterpene compounds  $\alpha$ -terpinene,  $\gamma$ -terpinene,  $\alpha$ -pinene,  $p$ -cymene, terpinen-4-ol,  $\alpha$ -terpineol, thymol, citral and 1,8-cineole were examined for their antiviral activity against herpes simplex virus type 1 (HSV-1) in vitro. These essential oils were able to reduce viral infectivity by >96%, the monoterpenes inhibited HSV by about >80%.

The mode of antiviral action has been determined, only moderate antiviral effects were revealed by essential oils and monoterpenes when these drugs were added to host cells prior to infection or after entry of HSV into cells. However, **both essential oils and monoterpenes exhibited high anti-HSV-1 activity by direct inactivation of free virus particles.** All tested drugs interacted in a dose-dependent manner with herpesvirus particles thereby inactivating viral infection. Among the analysed compounds, monoterpene hydrocarbons were slightly superior to monoterpene alcohols in their antiviral activity,  $\alpha$ -pinene and  $\alpha$ -terpineol revealed the highest selectivity index.

**However, mixtures of different monoterpenes present in natural tea tree essential oil revealed a ten-fold higher selectivity index and a lower toxicity than its isolated single monoterpenes.**

# MELALEUCA ERICIFOLIA

- This paperbark inhabits swamps and creeks along the east coast from the NSW mid-north coast south to Tasmania.
- The oil is known as nerolina or lavender tea tree
- Chemical constituents
  - No designated chemotypes
  - Association between with latitude and oil composition:
    - Northern provenance: high in linalool (To 55%), 1-8 cineole 13%, pinene 4%, terpinolene 3%, terpineol 3%
    - Southern provenance: Trace only of linalool, 1,8-cineole 47%, pinene 16%, limonene 18%, terpineol 7%.
- Use in aromatherapy
  - The aroma has a floral note due to the presence of linalool (Northern specimens). It is calming and relaxing.
  - As an alternative to tea tree, having similar antimicrobial properties but without the medicinal smell.
  - Used for upper respiratory infections and congestion, especially in children. Topically for acne, boils, tinea, Herpes infections, rashes, insect bites (Webb, 2000).
  - Can be used neat on skin, but best diluted in a 10% base.





# MELALEUCA TERETIFOLIA – HONEY MYRTLE

- This species occur in a limited area in SW. Western Australia.
- Chemotypes of leaf-oils (Brophy, Craven & Boland, 2013):
  - CTI was dominated by 1,8-cineole (81–88%). There were lesser amounts of  $\alpha$ -pinene (1–3%), limonene (3–4%), terpinen-4-ol (1–3%) and  $\alpha$ -terpineol (1–6%). Sesquiterpenes contributed very little to this oil, with the principal components being globulol, spathulenol and aromadendrene (all <0.3%). Oil yield (fresh weight w/w) 0.2%
  - CTI I gave an oil in which neral (29.1%) and geranial (38.8%) were the principal components. These were accompanied by lesser amounts of myrcene (9.8%), terpinen-4-ol (3.4%), E-isocitral (2.4%) and geraniol (2.1%). Sesquiterpenes were absent. Oil yield: The oil yield (fresh weight, w/w) was 1.5%. This oil is being developed commercially in Western Australia (The Paperbark Co. 2013).
  - This CT is a good potential source of citral
- Aroma described as a delicate, fresh, uplifting, lemon, honey aroma (Trevena, 2016)

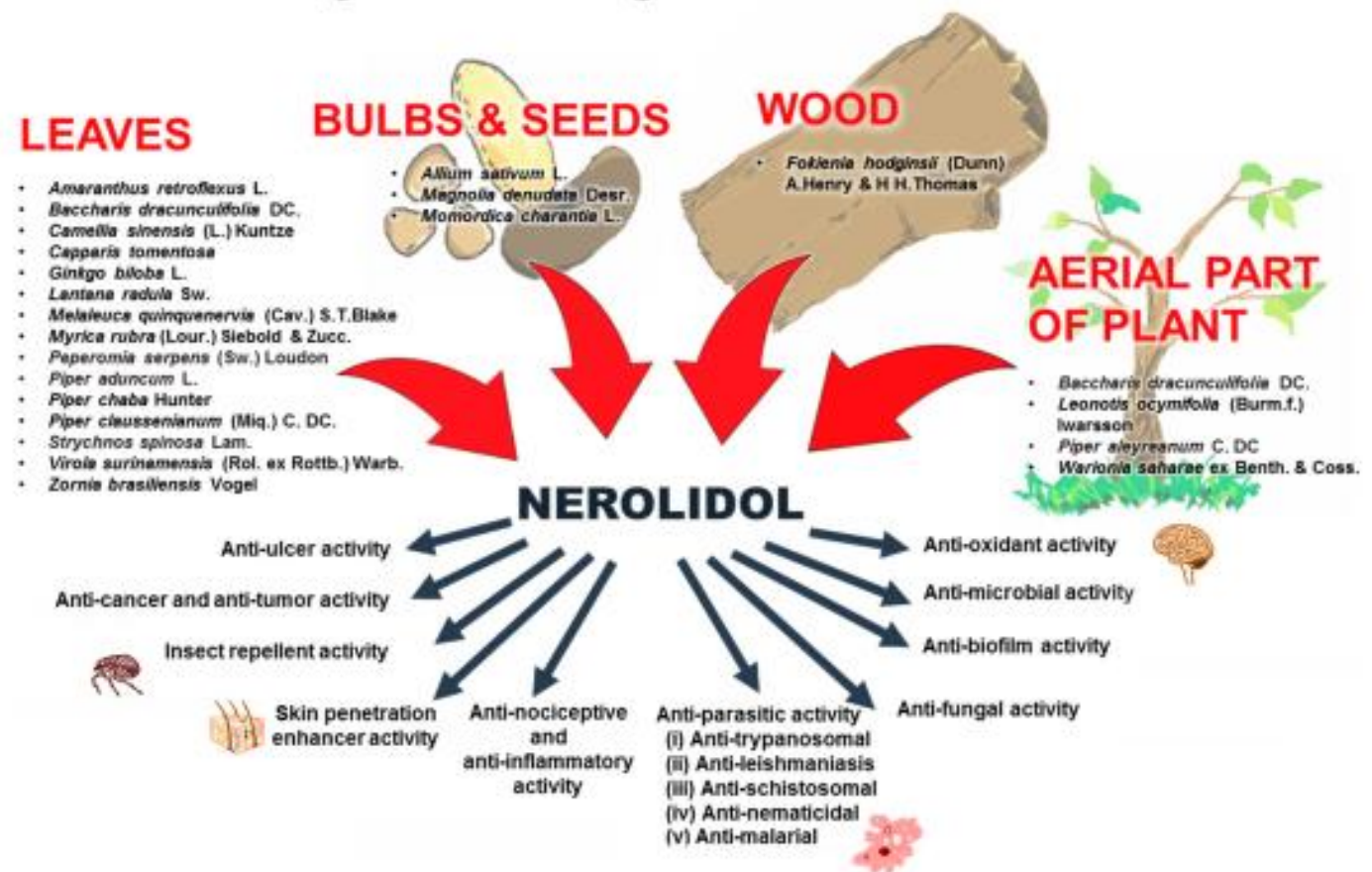


# MELALEUCA QUINQUENERVIA - NEROLINA



Photographer: Andrew Pengelly

## Pharmacological and Biological Activities of Nerolidol





# KUNZEA AMBIGUA – TICK BUSH

- This is a shrubby species with white staminate flower heads, found in coastal and sub-coastal regions of SE Australia.
- Patents for Du Cane ® Kunzea oil from Tasmania have been granted for Australia and 6 other countries  
<http://ducanekunzeaoil.com/html-english/homePage.shtml>
- Chemical constituents (Thomas, Narkowicz, Jacobson & Davies, 2010):
  - $\alpha$ -pinene (48%)
  - 1,8-cineole (14.5%)
  - Sesquiterpenes: variable levels of globulol (to 22%), viridifloral (to 38%)
- Kunzea oil is registered with the Australian TGA for the following conditions: can be used for:
  - the temporary relief of the pain of arthritis
  - relief of the symptoms of influenza
  - relief of muscular aches and pains
  - help in the relief of nervous tension, stress and mild anxiety
  - the temporary relief of the pain of rheumatism
- Use in aromatherapy
  - The aroma is described as fresh, spicy with a hint of cinnamon (Trevena, 2016). Pleasant with clean, fresh invigoration undertones (Webb, 2000)
  - Anecdotally the oil is beneficial eczema and dermatitis, under nail infections, leg ulcers, chilblains for repair of soft tissues following sprains and sports injuries (Webb, 2000).



<https://www.flickr.com/photos/22691568@N04/6926360760>

## Blending essential oils

This species blends well with Eucalyptus oils, and with sandalwood oil to enhance the effectiveness for arthritic pain (Trevena, 2016).



# TAXANDRA FRAGRANS - FRAGONIA

Syn. *Agonis fragrans*

cells demonstrated that *T. fragrans* oil was cytotoxic at 0.004% v/v but not at 0.002%. Exposure to one or more of the oils at concentrations of  $\leq 0.002\%$  v/v resulted in a dose responsive reduction in the production of proinflammatory cytokines IL-6 and TNF- $\alpha$ , regulatory cytokine IL-10, Th1 cytokine IFN- $\gamma$  and Th2 cytokines IL-5 and IL-13 by PHA stimulated mononuclear cells. Oil B inhibited the production of all cytokines except IL-10, oil X inhibited TNF- $\alpha$ , IL-6 and IL-10, oil A inhibited TNF- $\alpha$  and IL-6, oil C inhibited IL-5 and IL-6 and oil Z inhibited IL-13 only. IL-6 production was significantly inhibited by the most oils (A, B, C and X), followed by TNF- $\alpha$  (oils A, B and X). In conclusion, *T. fragrans* oil showed both antimicrobial and anti-inflammatory activity *in vitro*, however, the clinical relevance of this remains to be determined. Hammer et al. 2008

**Table 1** Major components (%) of five samples of *T. fragrans* essential oil<sup>†</sup>

Component	<i>T. fragrans</i> oil composition (%)				
	A	B	C	X	Z
1,8-Cineole	28.3	29.8	34.2	31.7	34.1
$\alpha$ -Pinene	28.0	25.1	24.2	20.9	13.7
Linalool	11.9	10.4	9.2	3.3	14.7
$\alpha$ -Terpineol	5.9	5.2	5.9	5.9	5.6
Myrtenol	3.4	1.7	4.1	5.5	4.5
Terpinen-4-ol	2.9	3.8	3.5	3.9	3.2
<i>p</i> -Cymene	2.5	2.4	2.6	2.8	2.5
Myrcene	2.1	1.8	1.6	2.6	2.7
$\gamma$ -Terpinene	2.1	2.4	2.0	2.0	1.9
$\beta$ -Pinene	1.9	1.8	1.6	2.1	1.4
Sesquiterpene alcohols <sup>‡</sup>	nd	nd	0.2	3.8	2.0
<b>Total</b>	<b>89.0</b>	<b>84.4</b>	<b>89.1</b>	<b>84.5</b>	<b>86.3</b>

<sup>†</sup>Data provided by the Wollongbar Agricultural Institute, Wollongbar, NSW, Australia.



# CLINICALLY USEFUL FORMULATIONS

## ■ Methods of application

- Vaporizers, diffusers, spritzers
- Essences (dilutions with ethanol)
- Steam inhalations, aromatic baths
- Aromatic hydrosols
- Addition to massage oils, liniments, creams and balms (typically 1-10%)
- Gargles, mouth washes, ear drops, suppositories, douches
- Oral ingestion in honey, milk etc
- Addition to tinctures, herbal infusions
- Medicinal wines, vinegars, elixirs
- Gelatin capsules

# SCOPE FOR AROMATHERAPY APPLICATIONS

- Skin disorders/topical applications
  - Insect bites, dermatitis, pruritis
  - Athletes foot, ringworm
  - Cuts, minor wounds, minor burns
  - Acne, boils
  - Muscular aches and pains
- Systemic disorders
  - Infections – due to rapid absorption and elimination of essential oils
  - Disorders of the psyche and nervous systems
  - Hormonal balance, stress relief
    - Schnaubelt, K. (1995). *Advanced aromatherapy*. Healing Arts Press.



# CONCENTRATION OF ESSENTIAL OILS FOR TOPICAL APPLICATIONS

## Recommendations from herbalist Rob Santich:

- The following ratios apply for addition of essential oils to pure vegetable oils (carriers) for topical use such as massage oils, ointments and healing salves.
- 0.5-2.5% Recommended for skin care applications such as blending essential oils into a base cream for dry skin, oily skin, eczema etc.
- 2.5% This dilution is quite suitable for full body massage especially during pregnancy or with young children.
- 5% For physical complaints such as cramps, sore muscles
- 10% Generally used for specific areas, such as tight shoulders, menstrual cramps etc.
- 10-20% for massage in cases of where the application of a strong physical dose is required, such as for fatigue, debility after illness, coming down with the 'flu etc.
- 20-50%. "Tiger Balm" for example is 60% essential oils, suited for application to specific areas for its local warming effects. Essential oils at 50% concentration in vegetable oils (50 /50) can be used for local treatment of herpes lesions, fungal infections, mild burns, wounds,

# EUCALYPTOL LINIMENT

- 10 parts Eucalyptus essential oil (*E. globulus* or *E. polybractea*)
- 10 parts cajuput essential oil (or honey myrtle CTI or Kunzea)
- 80 parts vegetable oil
  - Note: 10% ethanol or 20% brandy can replace equal volume of vegetable oil, for deeper penetration.
- Combine well and apply for temporary relief of muscular aches and pains.



# AROMATIC BALMS

## Basic Ointment Recipe

- 25% = quantities beeswax, cocoa butter
- 75% vegetable oils (eg jojoba, grape seed)

Add essential oils of Melaleuca, Eucalyptus, Kunzea



<https://www.etsy.com/listing/172604602/20-off-sale-item-vintage-very-small-cat>



# INSECTS



- Mosquito repellent
  - Make spritzer using 5 drops of essential oil from either of:
    - Lemon-scented gum, lemon myrtle Variety A, lemon-scented tea tree, lemon ironbark
    - Consider rotating the essential oil selection, to prevent insects becoming resistant to the scents, or for the human to become sensitized (Webb, 2000).
- Insect bites
  - Tee tree oil applied neat on the bite is the old standby. Kunzea oil has been used similarly.
  - Tee tree oil also effective against:
    - House dust mite
    - head lice, scabies when incorporated into shampoo preparations
- Leeches and ticks
  - Eucalyptus and tea tree oils have also been found to provide some benefit in preventing leech and tick bites, when sprayed in boots and clothing (Williams, 2011).





# HEAD LICE

- *Eucalyptus globulus* and other spp. high in 1,8-cineole also effective against head lice, including drug-resistant forms. (Williams, 2011)
- Kunzea oil

C. R. Williams and others

2

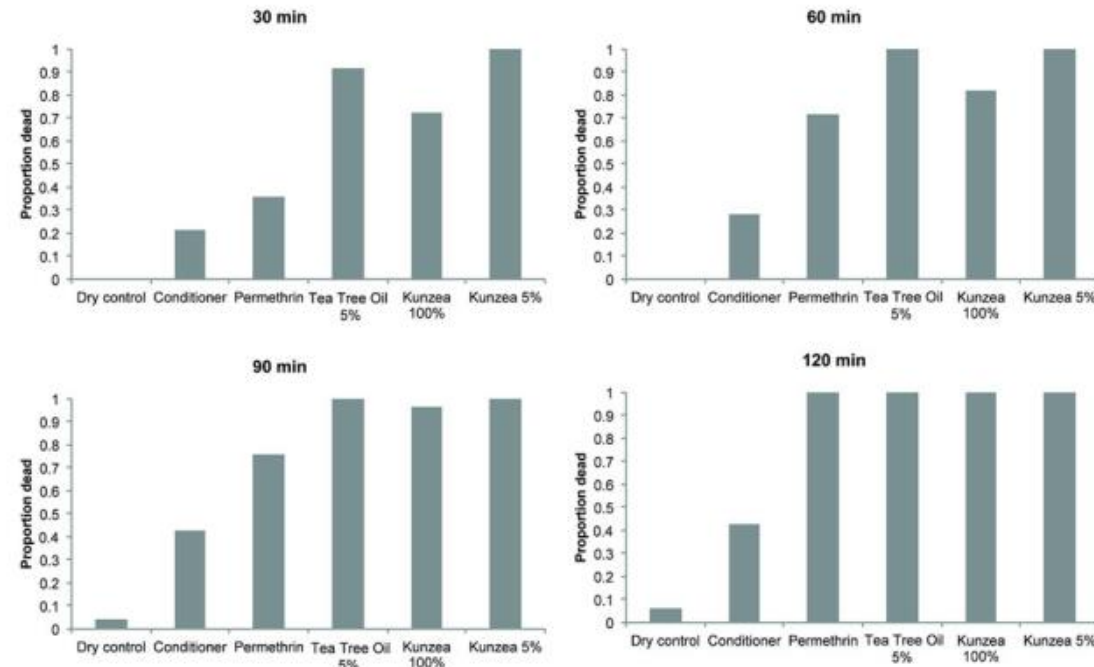


Fig. 1. Pediculicidal properties of kunzea oil preparations compared with positive and negative controls.

# EAR, NOSE AND THROAT DEPARTMENT

## Throat soothers and gargles

- Aromatic honey
  - 90 parts unfiltered honey or “medi-honey”
  - 10 parts essential oil (eg lemon-scented tea tree, niaouli, tea tree oil)
  - Mix well, take a small teaspoon every 15-20 minutes
- Alternative
  - 80 parts hydrosol of above essential oils
  - 20 parts honey
  - Mix well, use freely as throat gargle

## Ear oil – for mild external ear infections or mild ear aches

- 90% vegetable oil base eg. Mullein, Hypericum or Calendula infused oils. Alternatively sweet almond oil
- 10% essential oil (Eucalyptus, tea tree etc)
- Place 2-4 drops in ear, cover with cotton wool. Remove after 15 minutes
- This oil can also be applied to the lymphatic glands around the ear

Note: for blocked ears an aromatic diffuser can be used, to which 5 drops of *Eucalyptus dives* or *E. radiata* essential oils are added.



# EAR, NOSE AND THROAT DEPARTMENT

## Nose drops

- Essential oils diluted with vegetable oils for instillation into the nasal cavities. From 5 -10% essential oil
  - *Eucalyptus dives*, *E. elata*, *Melaleuca* species essential oils
- Squirt 2 to 4 drops of a blend up each nostril and inhale.
- Take this regularly for relief of blocked or stuffy nose and sinusitis.

## Eye drops

- Use aromatic hydrosols, such as sandalwood, Rosalina. Dissolve salt into waters at ratio of 9 grams per litre.
- Use 0.06% to 0.12% essential oils (0.6mL to 1.2mL per litre., or 24 to 48 drops per litre)

THANK YOU FOR WATCHING



Alembic copper still

<https://www.copper-alembic.com/en/>

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