PHYTOCHEMISTRY OF BUSH FOODS AND MEDICINES

ANDREW PENGELLY PHD. 2021

AN OVERVIEW OF THE POLYPHENOLS, TERPENES, ALKALOIDS AND OTHER PHYTOCHEMICALS, ALONG WITH THEIR THERAPEUTIC BENEFITS, FOR SOME PROMINENT AUSTRALIAN HERBS AND BUSH FOODS.

ANTA SYDNEY SEMINAR

ACKNOWLEDGEMENT OF COUNTRY

I would like to acknowledge the Traditional Owners throughout Australia and the Torres Strait Islands, and recognize their continuing connection and custody of land, waters and culture.

In particular I acknowledge the Kambuwal people of the Granite Belt-Southern Darling Downs region, and the neighbouring Jagera people of coastal SE Queensland.

JAGERA PSEUDORHUS

Named for the Jagera people; original inhabitants of the Brisbane region.

- Foambark tree
  - Rich in saponins
  - Bark traditionally used as a pish-poison
  - The bark was used as a substitute for the soap tree (*Quillaja saponaria*) during WWI
  - Once used for producing "foamy" head of beer
  - Flowers are very fragrant, good source of nectar for bees and other pollinating insects
    - Ref. Williams, CJ. (2012). *Medicinal Plants in Australia* vol. 3. Rosenberg.
  - Note: touching the fruit may cause irritation

WHY NOT TRULY AUSTRALIAN HERBAL MEDICINE?

- Traditional uses – ethnobotany
  - 60,000 + years
- Availability
  - Local
  - Leaf medicines – simple to harvest, evergreen
- Phytochemistry
  - Unique range of essential oils, polyphenols and others
- Pharmacological research is increasing
- Nutrients
  - Bushfoods have high nutrient levels when compared to global standards
- Cultural cringe?

PHYTOCHEMICAL CATEGORIES

- **Alkaloids**
- **Polyphenols**
  - **Tannins**
  - **Flavonoids**
  - **Anthocyanins**
  - Macrocarpals
- Terpenes
  - **Monoterpenes**
  - Sesquiterpenes
  - Diterpenes
  - **Triterpenes**
    - **Saponins**
    - Steroids/sterols

Essential oils

- Others
  - Polysaccharides
  - Gums and resins
  - Coumarins
- **Nutrients**

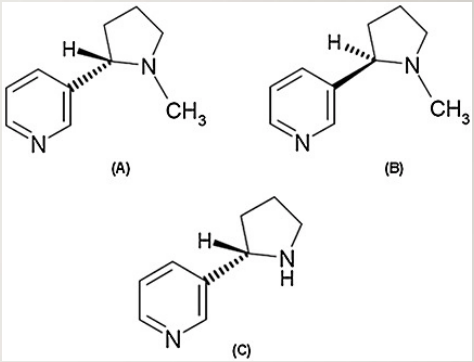
ALKALOIDS

SELECTED ALKALOIDS, THEIR ORIGINS AND ACTIONS

Alkaloid	Plant species	Origin	Actions
Nicotine, nornicotine Anabasine	*Nicotiana tabacum* *Duboisia hopwoodii*	North and Central America Australia	Adrenergic, central nervous stimulant, addictive
Hyoscyamine, atropine	*Atropa belladonna* *Duboisia myoporoides*	Europe Australia	Anticholinergic, anti-sialagogue spasmolytic Hallucinogenic
Scopalamine	*Datura mete1* *D. stramonium*	North America Naturalised in Australia	Anticholinergic, Central nervous system depressant, Anti-motionsickness
Cocaine	*Erythroxylon coca*	South America	Central nervous system stimulant, anesthetic
Quinine, quinidine	*Cinchona spp.*	South America, widely cultivated in SE Asia	Antimalarial, antiarrhythmic, Cardioactive
Morphine, codeine	*Papaver somniferum*	Asia, cultivated in Tasmania	Sedative, analgesic, addictive narcotic
Reserpine, alstonine	*Rauwolfia serpentina* *Alstonia constricta*	Asia Australia	Sedative, antipsychotic, antihypertensive
Ergotamine, ergonavine	*Claviceps purpurea* (fungus)	Europe	Vasoconstrictor, hypertensive Partus preparator (facilitates childbirth)
Caffeine	*Coffea arabica* *Thea sinensis*	Africa Asia	Central nervous system stimulant, diuretic, addictive
Solanine, solasadine	*Solanum spp.* *S. tuberosum* *S. aviculare, S. laciniatum*	Global South America Australia, New Zealand	Steroid precursor, anti-inflammatory, source of steroid and contraceptive drugs

PYRIDINE ALKALOIDS

- NICOTINE



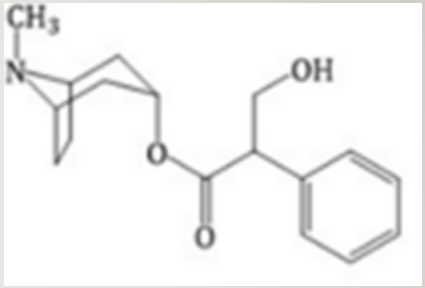
A. *S*-nicotine
B. *R*-nicotine
C. *S*-nornicotine
S-nicotine 6x potency of *R*-nicotine at acetlycholine receptors

- Pituri **(***Duboisia hopwoodii)* Solanaceae
  - Nicotine, nornicotine
- Other sources
  - *Nicotiana gossei* - rock pituri
  - *N. rosulata* – sandhill pituri
  - *Isotoma petraea* (Campanulaceae) – lobeline
- Traditional uses
  - Masticatory narcotic
    - Chewing tobacco
    - Suppress thirst, hunger

Duboisis hopwoodii
Image from Lucidcentral.org

Nicotiana gossei
Image from Lucidcentral.org

TROPANE ALKALOIDS
- HYOSCAMINE



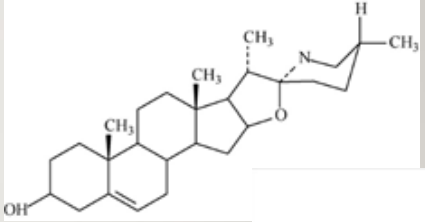
hyoscamine

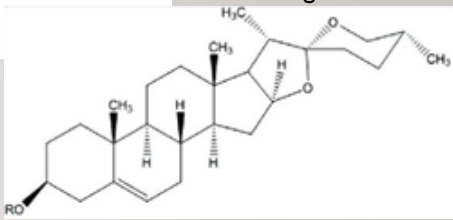
- *Duboisia myoporoides, D. leichhardtii*
  - Highest levels of tropane alkaloids worldwide
  - Australia is the leading source of these alkaloids
- Pharmacology and therapeutics
  - Acetycholine and muscarinic receptor blockers
    - spasmolytic effects on bronchial and intestinal smooth muscles
  - Hallucinogenic, toxic in low-moderate doses
  - Mydriatic – dilate pupils, eye surgery
  - Parkinsonism

Duboisia myoporoides—corkwood
Image from Wikipedia

GLYCOALKALOIDS

- SOLASODINE



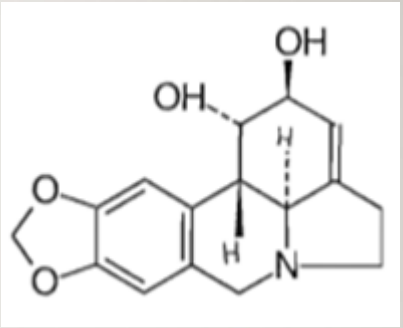


- aka. steroidal alkaloids
  - derived from cholesterol
  - Close resemblance to steroidal saponins eg diosgenin
  - Leading world source of steroid hormones and contraceptives
- *Solanum aviculare, S. laciniatum*
  - Unripe fruit of numerous Australian other *Solanum* spp.
- Pharmacology and therapeutics
  - Anti-inflammatory action consistent with other steroids
  - Antitumor and cancer preventative actions
  - Topical applications for eczema, cold sores etc.

Solanum aviculare. D.E.Symon Kangaroo Apples (1994), plate 1. Illustrator: G. Dashorst.

AMARYLLIDACEAE ALKALOIDS

- LYCORINE



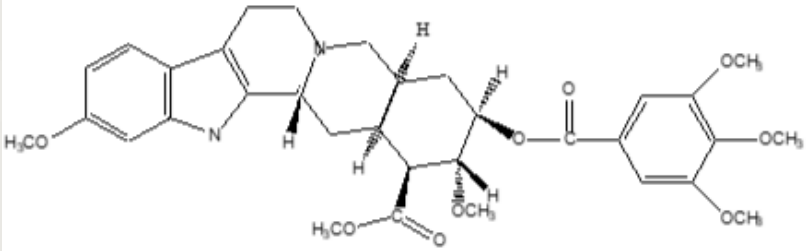
lycorine

- *Crinum pedunculatum* – crinum lily
- Traditional uses – bulb for treating marine stings
- Pharmacology and therapeutics
  - The alkaloids increases heart rate and blood pressure.
  - lycorine and related alkaloids have antiviral, antimalarial, cytotoxic, antitumor, sedative and analgesic activity
  - Quite toxic, external use only
  - Galanthamine from daffodil and snowdrops is a related alkaloid. It is an AChE inhibitor, used in treatment of AD

Flowering crinum lilies at Wolston Creek, Brisbane

INDOLE ALKALOIDS

- RESERPINE, ALSTONINE



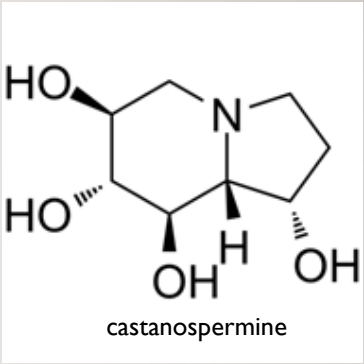
Reserpine

- *Rauwolfia serpentina* – Indian snakeroot
  - hypotensive, sedative and tranquillizing
- *Alstonia constricta* - bitter bark
  - Contains alstonine, alstonidine, reserpine
  - Hypotensive
  - Stem bark used for reducing fevers, influenza
- *Alstonia scholaris* – milky pine
  - Traditionally used for treating toothache, diarrhoea and rheumatism
  - Alkaloids from this species are antitussive, antiasthmatic, anti-inflammatory, analgesic and expectorant

Alstonia constricta—bitter bark. Photographer M. Fagg for Australian National Botanical Gardens.

INDOLIZIDINE ALKALOIDS

- CASTANOSPERMINE



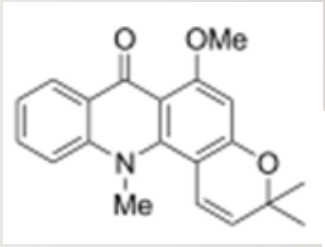
castanospermine

- *Castanospermum australe* – Moreton Bay chestnut
- Pharmacology and therapeutics
  - Glycosidase inhibitors (glycoproteins)
    - Interrupts mechanisms of cancer cells and viruses
    - Drug candidate for treatment of HIV-AIDS
    - Inhibits the Dengue fever virus in animals
  - Beans also contain toxic PAs
- *Swainsona canescens* and other *Swainsona* species
  - indolizidine alkaloid swainsonine
  - Also found in *Oxytropis, Astragalus* spp. (locoweed) in USA
    - Inhibits lysosomal amannosidase, responsible for hydrolysing mannose
    - deficiency causes mannosidosis, a neuromuscular and skeletal disorder
    - Promising antitumour and immunomodulating agent

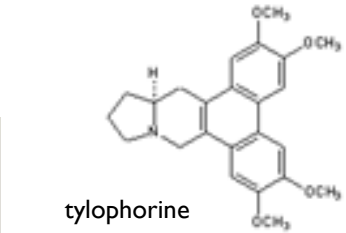

Castanospermum australe seeds and pods. Image from Australian National Herbarium.


Swainsona canescens. Image from Adelaide Botanical Gardens

OTHER ALKALOIDS



acrocycine



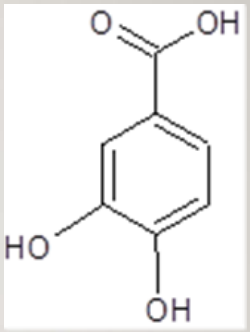
tylophorine

- Rutaceae alkaloids
  - acrocycine, a pyranoactidine alkaloid from *Sarcomelicope simplicifolia* – yellow aspen
    - lead antitumor drug in experimental and clinical studies
- Phenanthroquinolizidine alkaloids
  - cryptopleurine from (*Cryptocarya pleurosperma*) - poison walnut
    - stimulates nerve regeneration is small doses
    - May cause severe blistering and headaches
- Phenanthroindolizidine alkaloids
  - Tylophorine from *Vincetoxicum indicum* (syn. *Tylophora indica*) – Indian ipecac
    - potent anti-inflammatory, antiviral and anticancer actions

Yellow aspen, *Sarcomelicope simplicifolia*

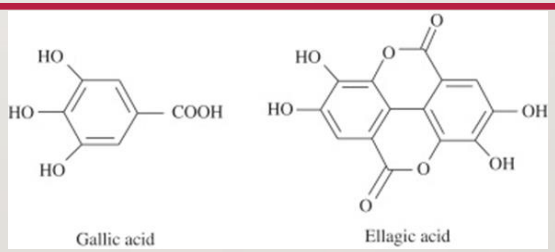
Vincetoxicum indicum
Image from Wikepedia

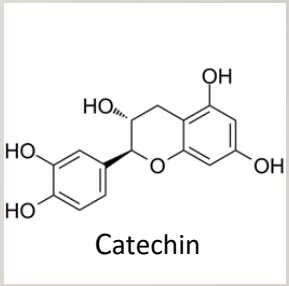
POLYPHENOLS



Protocatechuic acid

- Tannins:
  - Hydrolysable
  - Condensed

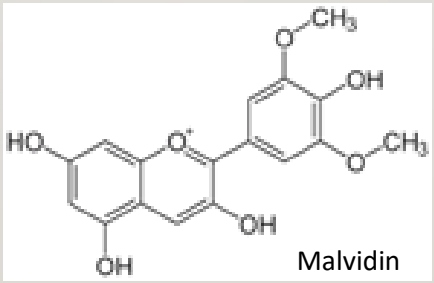




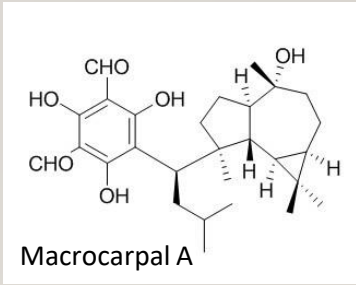
Catechin

- Flavonoids

- Anthocyanins

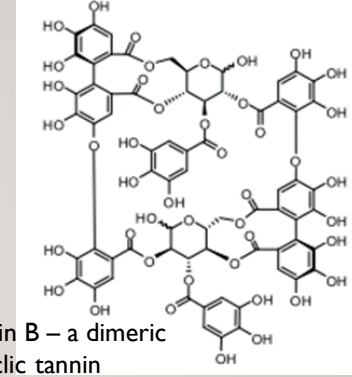


- Macrocarpals



TANNINS

- EUCALYPT TANNINS

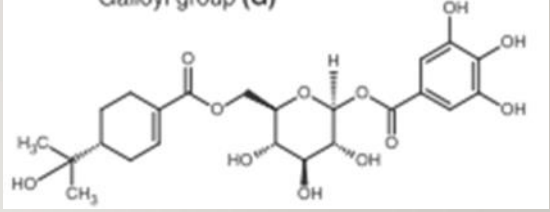


Oenothein B – a dimeric macrocyclic tannin

- Eucalypt polyphenols
  - Leaves, bark, fruit, kino
  - Hydrolysable and condensed tannins
  - Flavonoids
  - Macrocarpals
- Eucalypt kino
  - Trunk exudate may contain >50% tannins
  - Strong antimicrobial
  - Previously official in BP
- *Eucalyptus globulus*
  - Rich in gallotannins and ellagitannins
  - Oenothein B, potent antioxidant, anti-inflammatory, antibacterial agent reduces neuroinflammation in the brain in vivo

Kino exudate from marri *Corymbia calophylla* (Wikipedia)

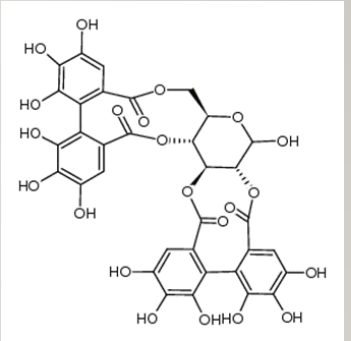
Eucalyptus globulus – Tasmanian blue gum



eucaglobulin

Eucalypt polyphenols (cont.)

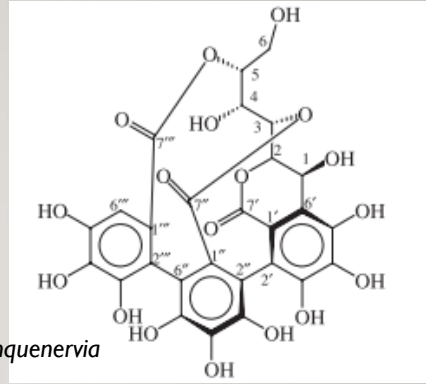
- Eucaglobulin and globulusin A – from *E. globulus* leaves
  - Consist of gallic acid linked to monoterpenes with glycosidic bonds.
  - These compounds demonstrated potent antioxidant, anti-inflammatory and anti-melanogenesis activity in vitro
- *E. camaldulensis* – river red gum
  - Dimeric ellagitannins, tellimagrandin and pedunculagin
  - Demonstrated potent antioxidant and cytotoxic actions.
  - Their potential as chemopreventative agent against breast, colon and other forms of cancer is under investigation



Pedunculagin, from *E. camaldulensis*

TANNINS

- MYRTACEAE FAMILY



Castalin from *Melaleuca quinquenervia*

- Most plants in this family are tannin-rich esp. ellagitannins
- Includes many notable essential oil producing species:

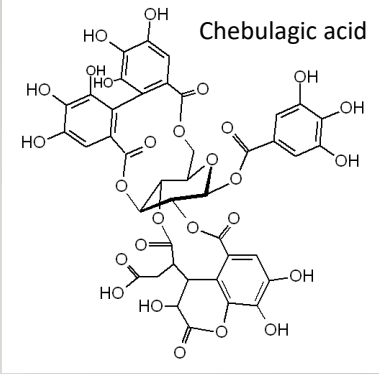
Botanical name	Common name
Backhousia citriodora	Lemon myrtle
Anethola anisata	Anise myrtle
Melaleuca quinquenervia, M. alternifolia	Paperbarks, tea tree
Syzygium spp.	Lilypillys
Leptospermum spp.	Tea trees
Kunzea ambigua	Tick bush

Leptospermum petersonii
Lemon-scented tea tree

- Combination of aromatic/carminative, antimicrobial, antioxidant and astringent actions
- Treat: digestive disorders, diarrhoea, respiratory infections, dental plaque, topicals
- Prevent: diabetes, cancer

TANNINS

- BUSH FRUITS



- Recent analyses demonstrate that many of our native foods have exceptionally high levels of polyphenols
- High antioxidant capacity by comparison with global standard – blueberry
- *Terminalia ferdinandiana* – Kakadu plum
  - World's highest content of vitamin C
  - High levels of tannins incl. the ellagitannins corilagen, castalagin and the benzopyrene chebulagic acid
  - Flavonoids incl. quercetin, luteolin
  - 6-13 times antioxidant capacity of blueberries
  - Broad-spectrum antimicrobial activity, particularly against bacteria responsible for some severe auto-immune inflammatory diseases

Kakadu plum *Terminalia ferdinandiana*
Images from www.fruitipedia.com

TANNINS

- TERMINALIA SPP.

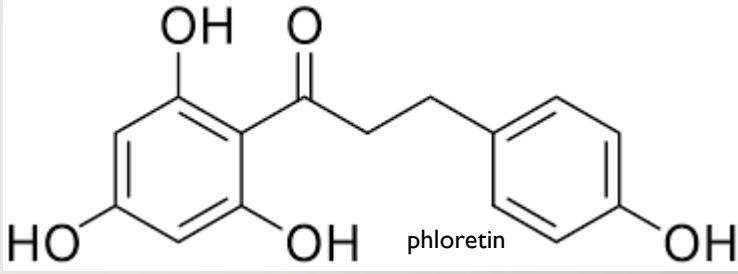
- Family - Combretaceae
  - *Terminalia carpentaria*, wild peach
  - *T. catappa*, beach almond
  - *T. macrocarpa,* rainforest damson
  - *T. grandiflora*, nutwood
- All species contain high levels of polyphenols in fruit, leaves, bark
- Compare Triphala, Ayurvedic “3-fruit” formula contains two *Terminalia* spp.
- the uses for Triphala extending beyond the digestive system to eye disorders, dental and oral health, cardiovascular disorders and liver protection and diabetes

Beach almond (*T. catappa*) growing as a weed on Fraser Island, Qld. Image from finia.org.au

Australian triphala?

SMILAX GLYCIPHYLLA

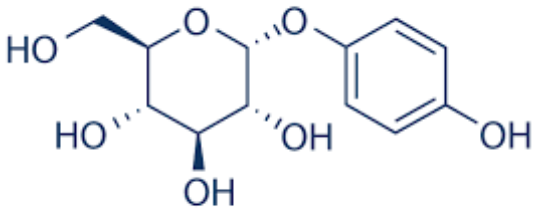
- NATIVE SARSAPARILLA



phloretin

- Traditional use
  - Early colonialists used it as an antiscorbutic
  - Popular for chewing while bushwalking
    - Sweet flavour
    - Queensland samples have little sweetness
  - Once marketed as a tonic
- Leaves contain sweet principle, glycyphillin
  - A dihydrochalcone
  - Rhamnoside of phloretin
    - Phloretin, constituent of apples
    - Antidiabetic, antitumor agent

PERSOONIA SPP.
- GEEBUNGS



Arbutin – a simple phenol

- Traditional uses
  - application of the juice derived from the fruit, for local treatment of skin infections due to infection by *Staphylococcus* bacteria, and for other skin disorders including psoriasis.
  - Thought to be *P. linearis*
- Research
  - extracts prepared from the ripening fruit of a hybrid of *P. linearis* and *P. pinifolia* was found to inhibit the growth of pathogenic bacteria (gram +ve and -ve) and a fungus (*Phytophthora cinnamomi*).
  - Further investigations revealed the presence of a single antimicrobial compound, a previously unknown phenolic glycoside ester, related to arbutin

Persoonia linearis - narrow leaf geebung

Logo for Indigenous Plants for Health Assn. Inc.

POLYPHENOLS IN ANISE MYRTLE, LEMON MYRTLE, TASMANIAN PEPPER LEAF

- ANTI-INFLAMMATORY ACTIVITY

Phenolic compounds in purified polyphenolic-rich extracts of anise myrtle, lemon myrtle and Tasmannia pepper leaf (mg/g DW).

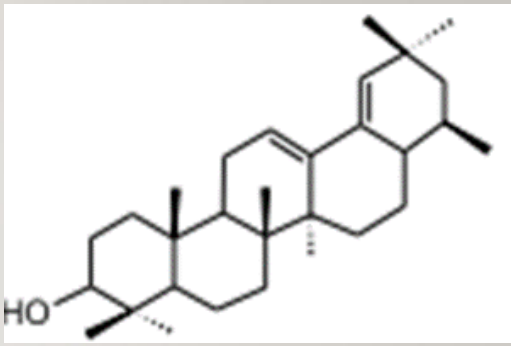
Compound	Anise myrtle	Lemon myrtle	Tasmannia pepper leaf
Ellagic acid	153 ± 0.7	102 ± 5.8	ND
Ellagic acid derivatives[a]	514 ± 10.0	360 ± 27.0	ND
Chlorogenic acid	ND	ND	288.2 ± 10.2
Catechin	17.3 ± 4.5	ND	ND
Quercetin[b,c]	29.1 ± 4.9	31.3 ± 6.2	45.6 ± 4.4
Quercetin 3-rutinoside[c]	ND	ND	68.3 ± 9.4
Myricetin[c]	1.04 ± 0.2	1.20 ± 0.2	ND
Hesperetin[c]	4.10 ± 0.6	5.37 ± 1.1	ND
Cyanidin 3-glucoside[d]	ND	ND	0.37 ± 0.01
Cyanidin 3-rutinoside[d]	ND	ND	0.02 ± 0.001

[a] Ellagitannins and ellagic acid glycosides were quantified as ellagic acid equivalent following hydrolysis based on the peak area at 250 nm.
[b] Includes quercetin glycosides with the exception of quercetin 3-rutinoside.
[c] Myricetin, hesperetin, quercetin and derivatives were quantified as quercetin 3-rutinoside equivalent based on the peak area at 370 nm.
[d] Cyanidins were quantified as cyanidin 3-glucoside equivalent.

The present study demonstrates for the first time the potential anti-inflammatory activities of native Australian herbs polyphenols-rich extracts: anise myrtle, lemon myrtle and Tasmannia pepper leaf. The anti-inflammatory activities occurred through down-regulation of iNOS and COX-2 enzymes and inhibition of the accumulation of their respective products, NO and PGE_2. This study has shown that anise myrtle and lemon myrtle potentially could be more efficient anti-inflammatory agents than Tasmannia pepper leaf.

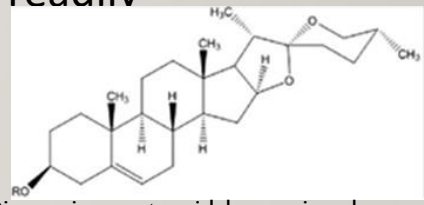
Y. Guo et al. / Toxicology Reports 1(2014) 385–390

TRITERPENOIDS AND SAPONINS



Oleanane ring system

- Saponins are widely distributed in the Australian flora.
- Like all terpene-derived molecules, triterpenes are insoluble in water, but when they bond with one or more sugars, they readily dissolve in water.



Diosgenin – a steroidal saponin aglycone

Saponin classification

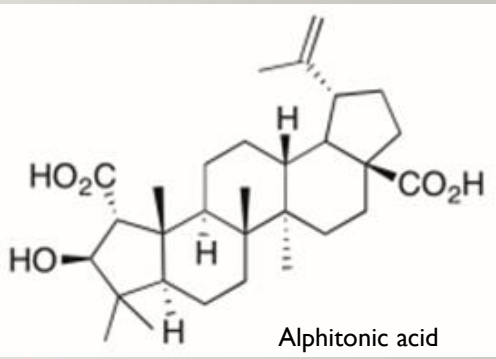
Non-sugar (aglycone) moiety ↓ sugar moiety eg glucose

→ triterpenoid = triterpenoid saponin

→ steroid = steroidal saponin

- The most widely distributed triterpenoid aglycone is oleanolic acid, from which the oleanane-type ring system derives

SAPONINS CONTRIBUTION TO INDIGENOUS PLANT MEDICINES



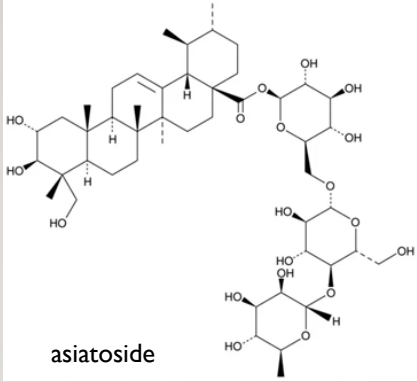
Alphitonic acid

- Emulsifying (saponifying) properties
  - Fish poisons (piscidisides)
  - Soap making, antiseptic wash
  - Local treatment of wounds, skin infections
  - Some species may cause haemolytic anaemia
- Actions associated with internal uses
  - Anti-inflammatory
  - Antimicrobial
  - Expectorants
  - Diuretics
  - Quickly metabolized, no risk of haemolysis
  - High doses may cause vomiting


Alphitonia excelsa – red ash, soap tree

CENTELLA ASIATICA

- GOTU COLA, INDIAN PENNYWORT



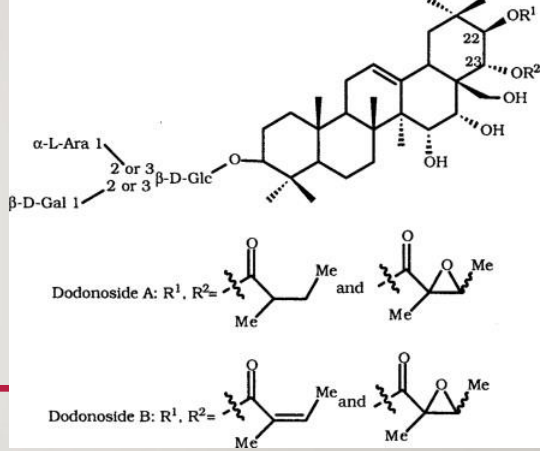
asiatoside

- Ayuverdic herb (Indian)
- Widely distributed in eastern Australia, particularly in coastal areas.
- Gotu cola contains mixtures of saponins and free triterpenoids of either ursane or oleanane structural types.
- Asiatoside (pictured) contains 3 sugar molecules attached to the ursane-type triterpene aglycone.
- In both traditional and modern herbal medicine, *C. asiatica* has been used for wound healing, eczema and psoriasis, burn and scar treatment, skin infections and for revitalizing connective tissue (James & Dubery, 2009).
- An asiatoside-enhanced *C. asiatica* extract was shown to be a potent wound healer in vitro and in vivo

Image from Wikispecies

DODONAEA VISCOSA

– STICKY HOP BUSH

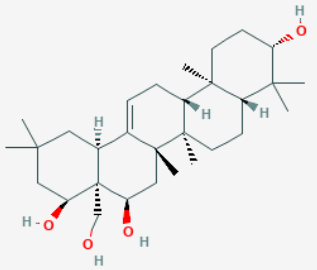


- Leaves are a rich source of triterpenoid saponins, flavonoids and diterpenes
- Saponins:
  - Jegosapogenol, jegosapogenol diangelate and doviscogenin have oleanane structures
  - Other saponins are dodonin, dodonosides A and B which were found to be barrigenol esters
- Therapeutic actions
  - Wound healing, antimicrobial, anti-inflammatory, analgesic, spasmolytic, anti-ulcer and anti-diarrhoeal properties

D. viscosa male flowers - Wikipedia

PITTOSPORUM ANGUSTIFOLIUM (SYN. P. PHYLLIROIDES)

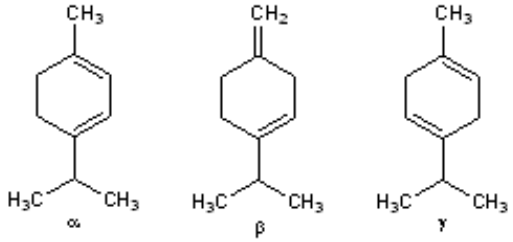
- WEEPING PITTOSPORUM, GUMBI GUMBI



Dihydropriverogenin A

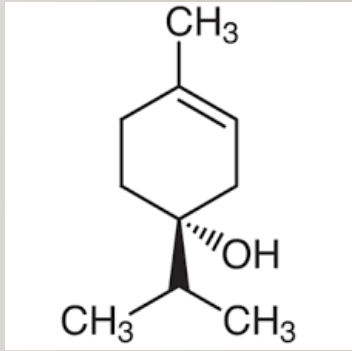
- Traditional uses
  - treatment of skin infections and eczema
  - muscular aches and pains
  - cancer remedy.
  - All parts of the plant have medicinal applications
- Phytochemistry
  - several pentacyclic (five carbon rings) triterpenoid saponins
    - phillyregenin, barrigenol, 27 - desoxyphillyrigenin, dihydropriverogenin A, 16 - desoxybarringtogenol C and barringtogenol C

ESSENTIAL OILS
- MONOTERPENES

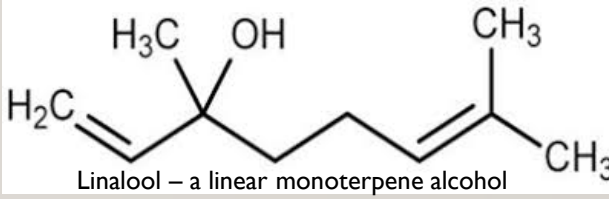


α, β and γ terpinene

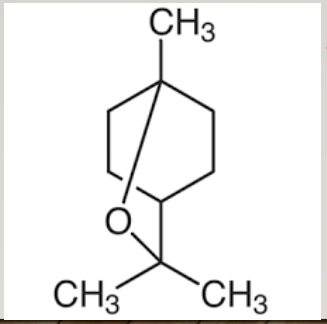
- Most common component of essential oils
- Smallest of the terpenes
  - C10 H15
- May be oxygenated
  - Alcohols, aldehydes, ketones, oxides
- Soluble in alcohol, fats
- Limited solubility in water



Terpinen-4-ol. A cyclic monoterpene alcohol alcohol



Linalool – a linear monoterpene alcohol



1,8-cineole. A monoterpenoid oxide.

EUCALYPTUS

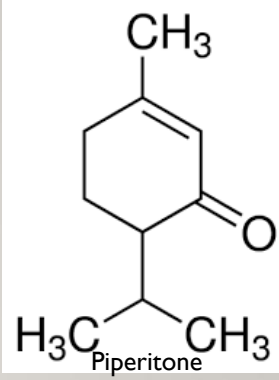
- Common constituents
  - Essential oil
    - 1,8-cineole dominant
  - Polyphenols
    - Tannins
    - Flavonoids
    - Macrocarpals
  - Triterpenoids
- Significant species
  - *E. globulus, E. polybractea, E. camaldulensis, E. robusta, E. dives, E. radiata, Corymbia citriodora*

Eucalyptus globulus

E. radiata flowers

EUCALYPTUS

- PEPPERMINTS AND THEIR CHEMOTYPES



Piperitone

- *E. dives* – broad-leaf peppermint
  - CT1
    - piperitone 52%, α-phellandrene 20%, globulul 6%
  - CT2
    - 1,8-cineole 70%, terpineol, citral
- *E. radiata* – narrow leaf peppermint
  - CT1 (*E. Australiana*)
    - 1,8-cineole 71%, α-pinene 15%, limonene 5%.
  - CT2
    - α-phellandrene 20%, p-cymene 14%, 1,8-cineole 13%, piperitone 12%


Eucalyptus dives

Data from Boland, Brophy & House, (1991)

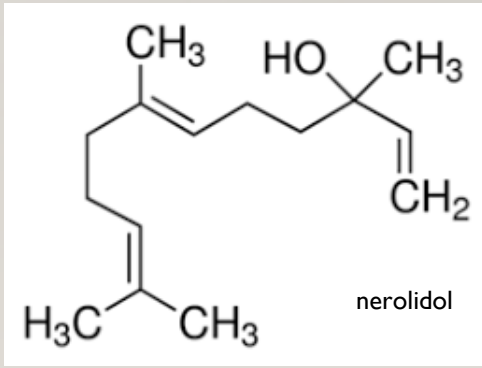
MELALEUCA SPP.

-TEA TREE OILS

Melaleucas chemotypes to know

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	α-terpineol
	quinquenervia	coastal paperbark 'nerolina' 'niaouli'	nerolidol 1,8-cineole	linalool 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

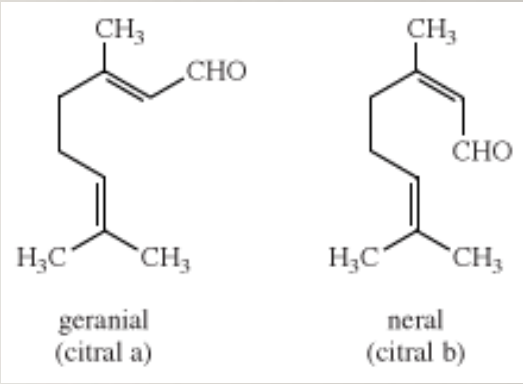


nerolidol

M. nodosa from Nth. Rothbury, NSW. 80% 1,8-cineole. 6% a-pinene

LEPTOSPERMUM PETERSONII

- LEMON-SCENTED TEA TREE



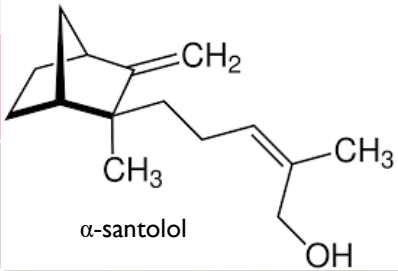
Constituent	CT1	CT2	CT3	CT4	CT5
Neral	31.3	13.5		0.5	
Geranial	45.4	22.8		0.3	
Citronellal	6.8	46.2			
∂-Terpineol	0	13.5		0.5	
Nerol	0.7	0.2			38.3
Geraniol	2.7	2.4	4.8		21.2
Terpinolene				17.6	7.3
a-Pinene	12.3	0.1	0.1	9.6	0.6
Terpinene				26.5	11.5
ß-caryophyllene			25		

Brophy et al (2000). Note the variation between the 5 chemotypes.

CT1 - common lemon-scented form ("type")
- variable citronellal/citral ratio
CT2 - citronella type
CT3 - sesquiterpene type
CT4 - terpinene/cajuput type
CT5 - rose-scented type

OTHER ESSENTIAL OIL SPECIES

Botanical name	Common name	Monoterpenes present
Backhousia citriodora	Lemon myrtle	Citral
Anethola anisata	Aniseed myrtle	Methyl chavicol
Kunzea ambigua	Tick bush	a-pinene, 1-8 cineole
Taxandra fragrans	Fragronia	Linalool
Eucalyptus stageriana	Lemon-scented ironbark	citral



α-santolol

Sesquiterpene-containing essential oils

Botanical name	Common name	Sesquiterpenes present
Santalum spicatum	Australian sandalwood	Santolol, bisabolol
Callitris intratropica	Blue cypress (leaf)	Guaiol, guaiazulene
Callitris glaucophylla	White cypress (wood)	Guaiol, citronellic acid
Eremophila mitchellii	Buddha wood	Eremophilone, santalcamphor

Australian essential oils and plant medicines for treatment of resistant infections

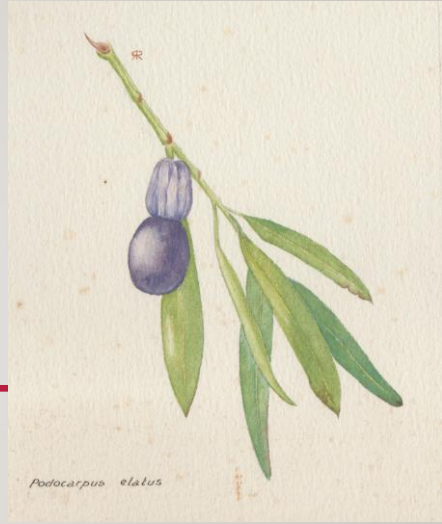
https://moneyweek.com/504987/the-drugs-dont-work-stopping-the-spread-of-the-superbugs/

Andrew Pengelly PhD

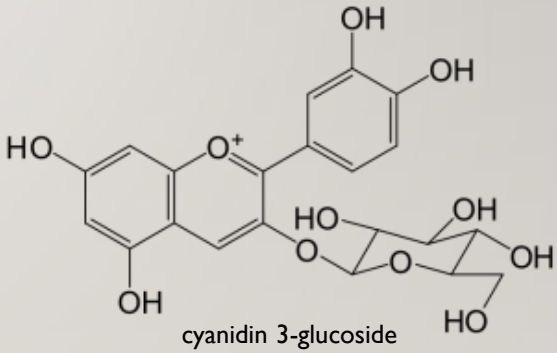
ANTA Conference Brisbane 2020

SELECTED PROFILES OF NATIVE FOODS

ILLAWARRA PLUM – *PODOCARPUS ELATUS*



- Highest levels of anthocyanins of fruit tested
  - cyanidin 3-glucoside
- Quercetin, luteolin, kaempferol glucosides, rutin
- Antioxidant capacity only topped by Kakadu plum.
  - 146% AC compared to blueberry



cyanidin 3-glucoside

- Suppression of cell proliferation, cell cycle arrest, and induction of apoptosis in colon cancer cells (Symonds, Konczak & Fenech, 2013)
- Prevent development of obesity in vivo
- Leaf essential oil high in sesquiterpenoids, pinene

QUANDONG
SANTALUM ACUMINATUM

Source – Eden seeds

- Traditional food and medicine tree of the outback
- Fruit - high levels of anthocyanins and other polyphenols
- 1.9x level of polyphenols compared to blueberry
- Most potent antioxidant capacity as per ORAC test
- Highest levels of vitamin E in Aust. fruit next to fingerlime
- Source of carbohydrate (17%) and fibre (4%)
- Exceeds other Aust. fruit for K content

DAVIDSON'S PLUM

- *DAVIDSONIA PRURIENS, D. JERSEYANA*

https://tasteaustralia.biz/bushfood/native-fruit/davidson-plum/

- High fruit yields and wide applications
- Fruits very high in anthocyanins
  - Delphinidin sambubiose
- Also present: ellagic acid derivatives, flavonoids, OPCs
- High antioxidant capacity
- High levels of manganese and potassium

NATIVE LIMES

- *CITRUS AUSTRALASICA* – FINGER LIME
- *C. GLAUCA* – DESERT LIME

http://www.gondwananativelimes.com.au/australian_native_finger_lime.html

- Highest level of vitamin E
- Vitamin C content behind Kakadu plum and Syzygium spp.
- Both species provide less antioxidant capacity than blueberries
- Good source of calcium

RIBERRY

- *SYZYGIUM LEUHMANII, SYZYGIUM* SPP.

https://ppnn.org.au/plantlist/syzygium-luehmannii/

- Fruit contains high levels of polyphenols:
  - Anthocyanins, mainly glycosides of cyanidin
  - Flavonoids, quercetin and kaempferol glycosides
- Good source of copper, calcium, magnesium and potassium
- Leaves rich in essential oil and tannins

NUTRIENT PROFILES
- NATIVE FRUITS

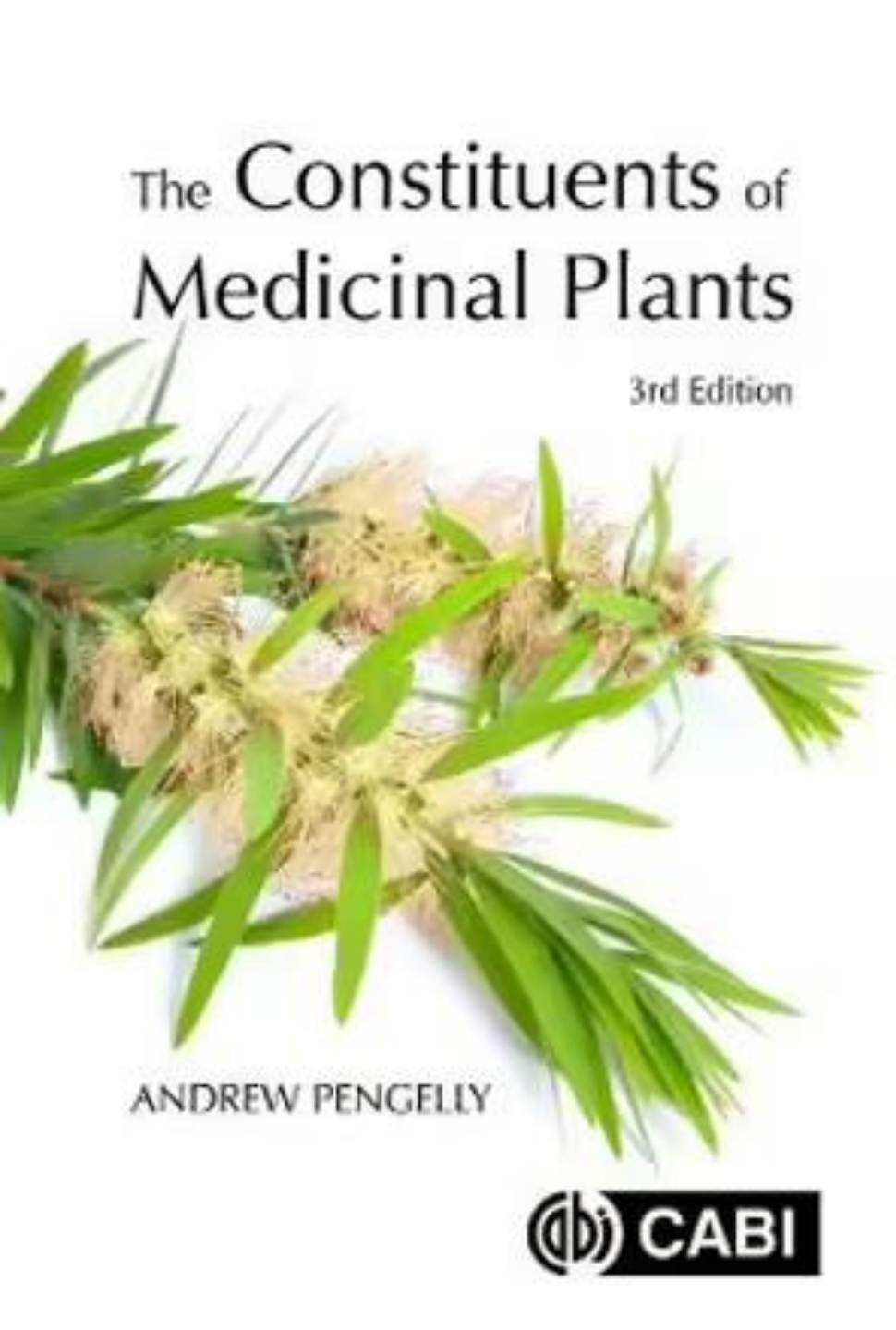
Lipophilic phytochemicals in commercially grown native Australian fruits. I. Konczak, P. Roulle / Food Research International 44 (2011) 2339–2344

Fruit	Vitamin E components (mg/100 g FW)			Vitamin E (mg/100 g FW)	Lutein (mg/100 g FW)
	α-Tocopherol	γ-Tocopherol	δ- Tocopherol		
Kakadu plum[a]	1.022 ± 0.107	0.021 ± 0.009	ND	1.041 ± 0.118	0.260 ± 0.014
Australian desert lime	0.701 ± 0.177	0.081 ± 0.017	ND	0.783 ± 0.194	0.295 ± 0.013
Lemon aspen	0.282 ± 0.047	0.010 ± 0.003	ND	0.292 ± 0.051	ND
Davidson's plum[a]	0.040 ± 0.003	0.030 ± 0.001	0.020 ± 0.002	0.092 ± 0.007	0.092 ± 0.009
Finger Lime (green)	0.517 ± 0.033	0.004 ± 0.0004	ND	0.521 ± 0.033	0.401 ± 0.027
Finger Lime (pink)	2.335 ± 0.233	0.025 ± 0.002	ND	2.360 ± 0.235	0.139 ± 0.011
Riberry	0.229 ± 0.044	0.001 ± 0.0005	ND	0.230 ± 0.040	ND
Quandong	1.165 ± 0.078	0.086 ± 0.005	0.038 ± 0.005	1.289 ± 0.082	ND

- level of lutein in Kakadu plum was similar to that of kiwi fruit, up to 5x that of acerola cherry.
- level of lutein in Australian limes contain higher levels of lutein than lemon and grapefruit juices

Mineral element contents (mg/100 g DW) of selected native Australian fruits.

Fruit	Fe	Cu	Mn	Zn	Ca	Mg	K	P	Se	Mo	Ni	Cd	Pb	Al	Co	Na
Australian desert lime	4.740	0.641	0.877	1.060	384.2	94.5	1287.8	127.8	<0.001	0.0077	0.048	0.0055	0.004	3.875	0.004	2.2
Kakadu plum	3.990	0.303	3.500	0.574	282.4	203.8	1905.5	52.45	<0.001	0.0185	0.036	0.010	0.007	0.521	0.005	10.4
Lemon aspen	13.25	0.834	10.02	3.925	133.3	147.6	1512.9	129.0	<0.001	0.0128	0.443	0.0435	0.008	2.670	0.008	45.0
Davidson's plum	1.240	0.638	19.55	0.426	217.3	138.1	1465.5	94.45	<0.001	0.0109	0.0160	0.0085	0.004	22.80	0.003	1.7
Quandong	16.55	0.100	0.288	4.240	133.3	217.9	3456.2	96.90	<0.001	0.0556	0.0153	0.0315	0.023	4.935	0.002	306.0
Riberry	4.320	1.135	22.75	1.315	307.7	189.0	1715.7	118.8	<0.001	0.0107	0.128	0.0245	0.208	1.665	0.008	47.1
Finger lime (green)	7.290	0.715	0.450	0.848	352.7	139.5	1459.6	166.9	<0.001	0.0104	0.0349	0.005	0.004	0.405	0.002	11.1
Finger lime (pink)	3.670	1.31	0.400	0.780	334.1	111.1	1242.6	141.7	<0.001	0.0083	0.0563	0.004	0.004	0.644	0.003	8.7



The Constituents of Medicinal Plants

3rd Edition

Andrew Pengelly, Maryland University of Integrative Health, USA

Apr 2021 | 232pp

Pengelly's book is a classic in the literature of herbal medicine. It is an easy to understand introduction to the chemistry of medicinal plants. This new edition is thoroughly updated incorporating topics of contemporary interest, including cannabinoids, mushroom polysaccharides, and toxicology of phytochemicals.

PB / 9781789243079 / ~~£25.00~~ £20.00 / ~~€30.00~~ €24.00 / ~~$35.00~~ $28.00
ePDF: 9781789243086 / ePub: 9781789243093

sales@cabi.org

Indigenous Plants for Health Association (Inc)

"Awareness, Research & Development of Indigenous Plant Based Products"

A Community Not for Profit Association

Indigenous Plants for Health is an incorporated association formed with the objectives of raising awareness, sourcing grants and sponsorship for sustainable production of indigenous plant-based products.

Originally established in the Hunter Valley (NSW) during 2018, we now have members around Australia, approximately 2/3 are in New South Wales.

Membership of IPHA is $20 / year

www.indigenousplantsforhealth.com

Indigenous Plants for Health Association (Inc)

"Awareness, Research & Development of Indigenous Plant Based Products"

A Community Not for Profit Association

- By promoting rural and Aboriginal community engagement, we aim to create opportunities for employment in the areas of sustainable land management, plant propagation, processing and marketing of indigenous plant products.

- IPHA will ensure opportunities and any rewards from such activities flow through to Aboriginal communities, in accordance with our objectives.

Scrub Nettle

Botanical name
Urtica incisa

Plant Family
Urticaceae

Distribution:: QLD, NSW, VIC, TAS, WA.

Description: Tender perennial with opposite paired, narrow, triangular leaves with toothed edges, covered in stinging hairs. Flowers small, greenish.

Edible: Young leaves cooked and eaten like spinach. Used to brew nettle beer & mixed with salt as a rennet substitute for making cheese. High in nutrients and minerals.

Medicinal Uses: Antimicrobial, adaptogen, tonic. Leaf poultice for sprains, leaf infusion as wash for sprains. Fresh plants used topically to relieve arthritic pain by slapping joint with fresh plant. Root powder or decoction for enlarged prostate. Dried leaf for anti-iinflammatory & nutritive tea.

Caution: Stinging hairs. Use young tips, new growth in teas; older leaves/stems develop gritty particles (cystoliths) that can irritate the kidneys.

Cultivation: Widespread weed, easily grown from seed. Grows best in slightly shaded, rich soil. Used as biodynamic compost.

Other species: The dwarf nettle, Urtica urens, and the common nettle *U. dioica* can be used.

Scrub Nettle
Urtica incisa

Deeply incised leaves
Flowers in small rounded groups on unbranched stems.
Secondary leaves in leaf/flower axils

REFERENCES

Aboriginal Communities of the Northern Territory of Australia. 1988. *Traditional Bush medicines. An Aboriginal Pharmacopoeia*. Greenhouse pubs.

Al-Snafi, A. 2017. A review on *Dodonaea viscosa*: A potential medicinal plant. *IOSR J. Pharmacy* 7(2), 10-21.

Amakura, Y. Yoshimura, M. et al. 2009. Marker constituents of the natural antioxidant Eucalyptus leaf extract for the evaluation of food additives. *Biosc. Biotechnol. Biochem.* 73(5): 1060-1065.

Azis, H.A. et al. 2017. In vitro and in vivo wound healing studies of methanolic fraction of *Centella asiatica* extract. *S. African J Botany* 108, 163–174

Banerjee, J. et al. 2019. Synthesis and Preliminary biophysical and cellular evaluation of some ring-enlarged analogues of the anti-tumor plant alkaloid acronycine. *ACS Omega* 4, 610606113.

Boland, DJ. Brophy, JJ. & House, APN. (1991). *Eucalyptus Leaf Oils*. Intaka Press, Melbourne

Boulekbache-Makhlouf, L. et al. 2012. Qualitative and Semi-quantitative Analysis of Phenolics in Eucalyptus globulus Leaves by High-performance Liquid Chromatography…*Phytochemical Analysis*. DOI 10.1002/pca.2396Cock, I. 2020. Alphitonia excelsa (Fenzl) Benth. Leaf Extracts Inhibit the Growth of a Panel of Pathogenic Bacteria. *Pharmacognosy Communications* 10(2), 67-74

Courtney et al., 2015. Tannin components and inhibitory activity of Kakadu plum leaf extracts against microbial triggers of autoimmune inflammatory diseases. *Pharmacognosy Journal*, 7(1), 18-31

Cox, SD. Jayasinghe, KC. & Markham, JL. (2005) Antioxidant activity in Australian native sarsaparilla (*Smilax glyciphylla*). *J Ethnopharmacol* 101 (2005) 162–168

Elgorashi. E. 2000. Alkaloids from three South African Crinum species. PhD Thesis. University of Natal, Pietermaritzburg S.A.

Evans, W. (1990) Medicinal and poisonous plants of the Solanaceae. *Br J Phytotherapy*, 1, 26-31.

Ferriera et al. 2021. Phytochemical profile and ethnopharmacological applications of Lecythidaceae: An overview. *J. Ethnopharmacology* 274, 114049

Gardner, CA. & Bennetts, HW. 1952. Poison Plants - Pituri. *J. Department of Agriculture, WA*, Series 3, 1(1) , Article 11.

Ghisalberti, E. L. 1998. Ethnopharmacology and phytochemistry of Dodonaea species. *Fitoterapia*, LXIX, 99-113

Guo, Y. Sakulnarmrat, K. & Konczak, I. (2014) Anti-inflammatory potential of native Australian herbs polyphenols. *Toxicology Reps* 1, 385–390

Harris, CM. et al. 1989. 1epiaustralene, a new pyrrolizidine alkaloid from Castanospermum australe. Tetrahedon letters 30(42), 5685-5688.

Hasegawa, T. Takano, F. et al. 2008. Bioactive monoterpene glycosides conjugated with gallic acid from the leaves of Eucalyptus globulus. *Phytochemistry* 69(3): 747-753

Jia, X. et al. 2020. Possible pharmaceutical applications can be developed from naturally occurring phenanthroindolizidine and phenanthroquinolizidine alkaloids. Phytochem Reviews. https://doi.org/10.1007/s11101-020-09723-3

Kohnen-Johannsen, K. & Kayser, O. 2019. Tropane alkaloids: Chemistry, pharmacology, biosynthesis and production. *Molecules* 24, 796

Lassak, EV. & McCarthy, T. 1983. *Australian Medicinal Plants*. Methuen, Sydney.

Konczak, I. 2017. In Cherikoff, V. *Wild Foods*. New Holland Pub.

Konczak , I. Zabaras, D. Dunstan, M. & Aguas, P. (2010) Antioxidant capacity and hydrophilic phytochemicals in commercially grown native Australian fruits. *Food Chemistry* 123,1048–1054

Konczac, I & Roulle, P. (2011). Nutritional properties of commercially grown native Australian fruits: Lipophilic antioxidants and minerals. *Food Res Int* 44, 2339–2344

References (cont.)

Netzel, M. et al., 2007. Native Australian fruits — a novel source of antioxidants for food. *Innovative Food Science and Emerging Technologies* 8, 339 – 346

Okuyama, S. et al, 2013 Oenothein B Suppresses Lipopolysaccharide (LPS)-Induced inflammation in the Mouse Brain. *Int. J. Mol. Science* 14, 9767-9778; doi:10.3390/ijms14059767

Pan, Z., Qin, X. J., Liu, Y.P., Wu, T., Luo, X.D., & Xia, C. (2016). Alstoscholarisines H-J, indole alkaloids from Alstonia scholaris: structural evaluation and bioinspired synthesis of alstoscholarisine H. *Organic Letters*, 18(4), 654–657

Ralphs, MH. Et al. 2007 Relationship between the endophyte Embellisia spp. and the toxic alkaloid swainsonine in major locoweed species (Astragalus and Oxytropis) . *J Chem Ecology* 34, 32-38.

Saranya, K. & Divyabharathi, U. 2019. Phytochemical and histochemical screening of *Dodonaea viscosa* leaves. *Pramana Research J.* 9(2), 53-59

Savigni, D. 2016. In Sultanbawa, Y. (ed) *Australian native plants: cultivation and uses in the health and food industrie*s. CRC Press. p. 186.

Singab, A. et al. 2011. Phenolic Constituents of Eucalyptus camaldulensis Dehnh, with Potential Antioxidant and Cytotoxic Activities. *Records of Natural Products* 5:4 271-280

Symonds,1. Konczak, I. & Fenech, M. (2013) The Australian fruit Illawarra plum (Podocarpus elatus Endl., Podocarpaceae) inhibits telomerase, increases histone deacetylase activity and decreases proliferation of colon cancer cells. *Br J Nutrition* 109, 2117–2125

Tellequin et al, 1998. Acronycine-type alkaloids in Pelletier, SW (ed). *Alkaloids: Chemical and biological perspectives V.12*. Pergamon

Walker, B. Kowalski , M. Goh, G. et al. 1987. Inhibition of human immunodeficiency virus syncytium formation and virus replication by castanospermine. *Proc. Nati. Acad. Sci. USA* 84, 8120-8124

Webb, LJ. 1969. Australian plants and chemical research. In *The Last of Lands* Jacaranda Press pp. 82-90.

Webb, LJ. 1972. Eat, die and learn—the botany of the Australian Aborigines. *Mankind*, 32-33

Williams, C. 2011. *Medicinal Plants in Australia. Vol. 2* Rosenberg.

Upton, R. & Mukherjee, S. 2020. Triphala (three fruits). *American Herbal Pharmacopoeia*.

Vesoul, J. & Cock, IE. 2011. An Examination of the Medicinal Potential of *Pittosporum phylliraeoides*: Toxicity, Antibacterial and Antifungal Activities. *Pharmacognosy Communications* 1(2), 8-17

Wagner, H., Ludwig, C., Grotjahn, L. and Khan, M. S. Y. 1987. Biologically active saponins from *Dodonaea viscosa. Phytochemistry* 26, 697-701.