IPHA Health-Promoting Plants Series

Acacia spp. Family. Leguminosae. Sub-family. Caesalpinioideae

Part 1

By Andrew Pengelly PhD

Acacia –derived from the Greek, *ake* (= a point), in reference to the spiny stipules that characterised the first (African) species described as *Acacia*; these species now belong to the genus *Vachellia*.

Taxonomy of Acacia

Acacia is the second largest genus in the Leguminosae (legume) family, containing over 1100 species. With some exceptions, distribution of the genus is restricted to Australia. Plants from other continents, particularly Africa, have been consigned to new genera such as *Senegalia* and *Vachellia.* These genera are noted for bearing large spines or thorns. While a few species from these genera are native to Australia, others have become naturalised.

The *Acacia* genus is traditionally subdivided into seven sections (Pedley, 2019). The name of one major section, the Phyllodineae, refers to the leaf-like phyllodes, which are in fact modified petioles and rachis, as distinct from true leaves. Another section, the Plurinerves, is so named because the phyllodes contain more than one prominent vein or nerve. A third section, the Botrycephalae, contains true leaves, which are bipinnate in shape (Table 1).

While all *Acacia* species have potential health-promoting properties, this profile will deal with four representatives of this amazing genus.

Table 1. Sections of *Acacia* genus covered in this profile

Section	Description	Examples
Phyllodineae	Phyllodes flat with one prominent longitudinal nerve. Flowers not in racemes.	*Acacia victoriae*
Plurinerves	Phyllodes flat with more than one prominent longitudinal nerve. Flowers in heads	*Acacia implexa*
Botrycephalae	True leaves, bipinnate. Flower heads in axillary racemes	*Acacia mearnsii* *Acacia decurrens*

Description and distribution

Acacia mearnsii De Wild. Black wattle

Mearnsii is named after American naturalist Edgar Alexander Mearns.

Small tree 10-16m high with smooth bark. The branchlets are angular and ridged with a soft tomentose surface. Leaves are dark green, finely bipinnate having short pinnae (< 6mm) with up to 30 pairs per leaf. 1 or 2 raised interjugary glands occur between pairs of pinnae. Pale yellow flowers heads are arranged in axillary or terminal racemes. Flowers appear Oct-Dec. Dark-coloured pods are constricted between seeds, 3–15cm x 5–8mm (Worldwide Wattle, Flora of Australia, 2001).

A. mearnsii grows near the coast and rangelands of NSW, Victoria and Tasmania, plus a few coastal sites in SA and WA. It prefers open forest, woodland or tussock grassland, in sandy or gravelly clay soils

Image from Wikipedia

Distribution map from https://en.wikipedia.org/wiki/Acacia_mearnsii

Acacia implexa Willd. Lightwood, hickory wattle

Implexa is derived from the Latin for entangled; referring to the seed pods with a tendency to form an entangled mass.

Small tree to 12m high, freely suckering; bark is rough and greyish, the branchlets glabrous. Phyllodes are narrowly elliptic or falcate, 7–20cm x 6–25mm wide, the juvenile leaves being longer and narrower than the adult leaves. Phyllodes are green with 3 prominent and up to 4 less prominent veins, with anastomosing minor veins in between. There is one inconspicuous gland near base of phyllode. Flowers are pale yellow in globular heads arranged in racemes up to 6cm long. Flowers appear Dec-April. Pods are brown, curved or coiled, slightly constricted between seeds, 6-20cm x 4-7mm.

A. implexa is found in dry forests across most of Victoria, eastern NSW and S.E. Queensland, also occurring in the Cape York region

Photo by Andew Pengelly

Distribution map from https://apps.lucidcentral.org/wattle/text/entities/acacia_implexa.htm

Acacia decurrens Willd. Black wattle, early green wattle

Decurrens is derived from the Latin decurrent, running downward; referring to the basal margins of a leaf extending down the stem below the leaf insertion, sometimes forming ridges.

Tall shrub to small tree to 12m high, bark smooth or fissured; branchlets angled with winged ridges which are continuous with the petioles; leaves are dark green, bipinnate in shape, with 3-13 pairs of pinnae, 3-9cm long, pinnules 5-15mm long. Jugary glands are present at all pairs of pinnae, but not in between them. Flower heads are bright yellow, arranged in axillary or terminal racemes. Flowers appear July-Sept. Pods are dark brown, more or less straight-sided and flat, 2-10 x 4-8mm.

A. decurrens occurs naturally in the Sydney region, Hunter Valley and the ACT. It is naturalised in the southern states including southeastern WA following widespread plantings. It prefers open forest and woodland on shale soils.

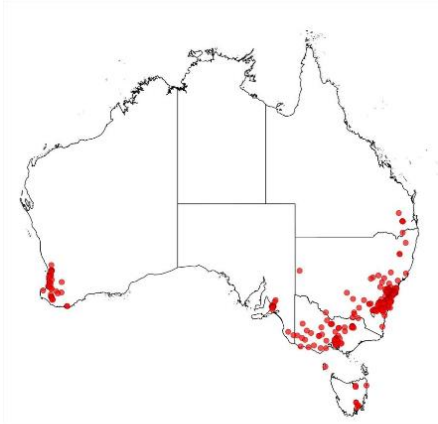


Image from Wikipedia Distribution map from https://apps.lucidcentral.org/wattle/text/entities/acacia_decurrens.htm

Acacia victoriae Benth. Elegant wattle, gundabluey, thambarli

Victoriae is named after the Victoria River, where the plant was found by explorer Major Mitchell in 1846. The river subsequently has been renamed the Barcoo.

Spreading shrub to a height of 7 m with suckering habit, prone to form thickets; branchlets glabrous or tomentose. Phyllodes are quite variable in shape, from narrow elliptical to oblong or lanceolate, 2-8cm x 2-8mm, apex has a mucro. Small gland near base of phyllode. It has spiny stipules, particularly in young plants. Pale yellow or creamy globose flower heads are arranged in axillary racemes up to 10 cm long; flowers appear Aug-Nov. Pods are mottled brown, flat, straight or slightly curved, 3-8cm x 9-16mm.

A. victoriae is widely distributed across inland Australia, particularly in the north of the continent, extending to coastal areas in North Queensland, WA and around Port Augusta in SA. It mostly grows in clay soils and alluvial flats.

Image from Wikipedia Commons   Distribution map from https://apps.lucidcentral.org/wattle/text/entities/acacia_victoriae.htm

Edibility

Wattles have been a significant source of food for Aboriginal people for thousands of years. The parts used are the seeds, gum, blossoms and, for a few species, roots. Seeds and roots are generally roasted, while gum can be eaten raw or soaked in water to make a jelly. Wattle gums from *A. decurrens* and other species are valued as a snack food, particularly for children, and they have purportedly saved lives of people lost in the bush (Williams, 2011). It is estimated that close to 100 species have been utilised for food purposes, over half of which come from their seeds (Cherikoff & Isaacs, 1993). Another traditional source of food provided by Acacias are insect larvae and galls.

Acacia victoriae is the most widely used source of edible seeds, being the species most favoured by the bushfood industry. Bearing plentiful large seeds, it provides a delicious flavour upon grinding into flour for baking into damper or cakes. Roasted seeds are also used as a caffeine-free hot beverage. Seeds of the species are readily available in selected retail outlets and online. *A. victoriae* along with *A. aneura* (mulga) can be harvested from wild plants in inland regions. At least 18 species have been identified as having good prospects for cultivation as seed for food crops in the southern semi-arid regions of Australia alone (Maslin et al., 1998). All of these species belong to the Phyllodineae section. Be warned the harvesting, drying, seed removal, grinding and cooking is time consuming! For people living closer to the east coast, available species with edible seeds include *A. longifolia, A. sophorae, A. decurrens, A. floribunda, A. fimbriata* and *A. sauveolens.* Seeds of coastal species are traditionally eaten as a cooked vegetable. The remainder of this section is focused on *A. victoriae*

Nutritional properties

Proximal analysis performed by Adiamo et al. (2021) revealed that *A. victoriae* contained lower protein and fat (20 and 5.44 mg/100g dw respectively) compared to some other *Acacia* species tested, but that it was much higher in insoluble fibre. Legumes in general are good protein sources, and levels of protein in *A. victoriae* are in line with the widely consumed legume *Cicer arietinum* (chickpea). Legumes are also known for containing antinutrients such as phytic acid and trypsin inhibiting activity (TIA), however *A. victoriae* is relatively low in these factors (Adiamo et al., 2021). *A. victoriae* and other Acacia seeds are a good source of minerals, especially iron, potassium, sodium, magnesium and zinc (RIRDC 2009, Adiamo et al. 2021). Seed oils make up 5% of the dry weight of the seed, consisting of both saturated and unsaturated fatty acids (Seigler, 2003). Further details on nutrient and mineral levels are given in Table 2.

Table 2. Nutrient levels of *Acacia victoriae*

Nutrient	Item	Quantity	Reference
Protein		20.9 mg/100g dw	Adiamo et al., 2021
Fat		5.44 mg/100g dw	Adiamo et al., 2021
Starch		3.54 mg/100g dw	Adiamo et al., 2021
Glucose		7.24 mg/100g dw	Adiamo et al., 2021
Insoluble fibre		30.16 mg/100g dw	Adiamo et al., 2021
Vitamins	Vitamin E	5.286 mg/100g dw	RIRDC (2009)
	Folate	100 µg/100g dw	RIRDC (2009)
Minerals	Zn	3.105. mg/100g DW	RIRDC (2009)
	Mg	255.1 mg/100g DW	RIRDC (2009)
	Ca	434.4 mg/100g DW	RIRDC (2009)
	Fe	10.90 mg/100g DW	RIRDC (2009)
	Se	31.7 µg/100g DW	RIRDC (2009)
	P	227.5 mg/100g DW	RIRDC (2009)
	Na	43.90 mg/100g DW	RIRDC (2009)
	K	1147.6 mg/100g DW	RIRDC (2009)
	Mn	2.955 mg/100g DW	RIRDC (2009)
	Cu	0.836 mg/100g DW	RIRDC (2009)
	Mo	25.1 µg/100g DW	RIRDC (2009)
	Al	6.65 mg/100g DW	Adiamo et al., 2021
	B	4.56 mg/100g DW	Adiamo et al., 2021
Seed oils	Linoleic Linolenic saturated	62% 18% 18%	Seigler, 2003

Phytochemistry

Acacias in general are known to contain the following classes of phytochemicals: amines, simple alkaloids, cyanogenic glycosides, cyclitols, essential oils, diterpenes, fatty acids from seed oils, gums, non-protein amino acids, triterpenes, phytosterols, saponins, flavonoids, and both hydrolysable and condensed tannins (Seigler, 2003). None of the four species covered in this profile are reported to contain amines, alkaloids or cyanogenic glycosides. This section will focus mainly on the major phytochemical categories present in Acacias: gums, triterpenoids and polyphenols.

Gums and polysaccharides

Many plants, including Acacias, produce gummy exudates when the bark is damaged by injury or fungal attack, and which serves to heal the wound. These exudates are readily obtainable in relatively pure, undegraded form, though in some cases purification is still required. Gums are made up of branching chains of chemically linked sugars (monosaccharides) or their salts, and uronic acid derivatives (uronic acids are oxidation products of sugars). Gum arabic (aka gum Acacia) is the preferred gum of this class for the pharmaceutical industry. It is derived from the African species *Senegalia senegal*, (previously *Acacia senegal*) and *Vachellia seyal* (previously *Acacia seyal*). Gum Arabic was historically valued for its emulsifying, gelling, viscosity-increasing functions, for enhancing consistency and stabilizing pharmaceutical formulations. As of 2022 there was still a huge global demand for gum arabic, Senegal being the largest producer (4,000,000 tonnes) followed by Nigeria and other northern African countries (Williams, McKinsey & Jenks 2024). Phytochemically gum arabic consists of a highly branched polysaccharide plus small amounts of protein matter.

Gums from Australian wattles are much higher in tannins than the African counterparts, making them less desirable as ingredients in pharmaceutic products. However, they still have their uses. Gum extracted from *A. decurrens* was an early export product to the UK, and for many years was included in the British Pharmacopoeia. Gums from *A. implexa* have, upon examination, been found to consist of repeating chains of (1-3)-linked D-galactopyranosyl residues in the basal chain of the polysaccharide (Churms, Merrifield & Stephen, 1981).

Triterpenoids

The aerial parts and seeds of *A. victoriae* contain complex triterpenoid saponins known as avicins. These molecules contain multiple sugars as well as an acetamide functional group. Studies have shown that avicin D and G can inhibit cell growth in a variety of tumour cells via several mechanisms (Wang et al, 2010). Another triterpenoid, hederagenin, has recently been isolated from the bark of *A. implexa* (Ghani et al., 2023).

Avicin G

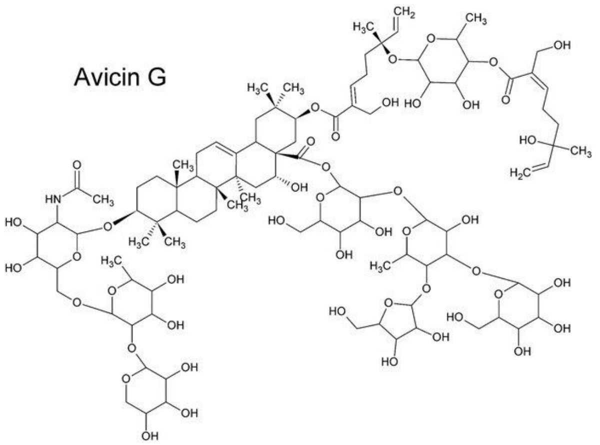


Image from https://www.researchgate.net/publication/336879175

Phytosterols are derived from triterpenes; they are structurally similar to mammalian steroid hormones, and have tumour inhibiting, cholesterol lowering and other beneficial effects in humans. Stigmast-7-enol, α-spinasterol and other phytosterols are found in the heartwood of many Acacia species, including *A. mearnsii* (Clark-Lewis & Dainis, 1967).

Polyphenols – tannins and flavonoids

Bark and leaves of most *Acacia* species are rich in tannins and flavonoids. Wattle tannins were heavily exploited in the 19th century, mainly as tanning agents but also for their medicinal properties. Preferred species included *A. mearnsii, A. pycnantha, A. dealbata* and *A. decurrens*. These barks contain an average tannin content of 40% (Williams, 2011). So heavily were they harvested that there was a concern about the diminishing availability of some species. The colonial botanist Joseph Maiden encouraged farmers to plant plots of wattle on places with poor soils that weren't suitable for regular crops (Maiden, 1891). Seeds of species including *A. decurrens* and *A. mearnsii* were also exported to countries such as South Africa, India and Hawaii, where they were cultivated for their tanning value.

Wattle tannins (aka Acacia polyphenols) can be categorised either as gallotannins, condensed tannins or complex tannins, the latter being a combination of 2 or more tannin units into one larger molecule. To add to the confusion, condensed tannins are also a category of flavonoids, however not all flavonoids are condensed tannins! Studies in South Africa highlighted that, unlike Acacias with phyllodes, the bipinnate Acacias (section Botrycephalae) *A. decurrens, A. dealbata, A. mearnsii* have no gallotannin in their bark or leaves (Roux, Maihs & Paulus, 1961).

The bark of *A. mearnsii* provides one of the richest sources of polyphenols, with a total phenolic count (TPC) of 621mg gallic acid equivalents/g (GAEs). These polyphenols consist mainly of condensed tannins, in the form of catechins (flavan-3-ol units) such as robinetinidol and fisetinidol, and their high molecular weight dimers and trimers (complex tannins). These tannins have demonstrated potent antioxidant, anti-inflammatory, antimicrobial, antidiabetic and antihypertensive effects (Xiong et al., 2017; Ikarashi et al., 2017; Ogawa & Yasaki, 2018).

Both bark and leaves of *A. implexa* are high in tannins, including gallo- and condensed tannins. The crude bark has the highest levels, with a TPC of 440 GAEs. Compounds present include gallic acid, protocatechuic acid, epichatechin gallate and procyanidin P2 (Ghani et al., 2023). Acacia heartwoods have also been exploited for their tannins. In a study of five Acacia heartwood methanolic extracts, *A. decurrens* reported a TPC of 101GAEs, however the most potent heartwood was recorded from *A. crassicarpa* with a TPC of 259 GAEs (Prayogo et al., 2021).

Certain flavonoids including rutin, quercetin, rhamnetin and kaempferol are widely distributed in the plant kingdom; hence they are also among the most widely studied molecules of this class. These four flavonoids are found in the leaves of *A. implexa*. Rutin is also reported in *A. decurrens,* while other flavonoids such as quercitrin, myricitrin and myricetin-3-O-glucoside are reported from *A. mearnsii.* In a recent study, myricitrin and myricetin-3-O-glucoside extracted from leaves of *A. mearnsii* demonstrated potent antioxidant effects, an addition to strong inhibition of α-glucosidase and α-amylase, enzymes associated with the development of type II diabetes (Wu et al., 2023).

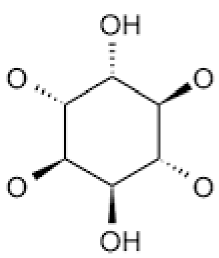
Polyphenols have been reported from the seeds of *A. victoriae*, mainly for their potential antinutrient effects. However little data is available with respect to other plant parts, such as bark and leaves.

Table 3. Polyphenolic compounds in three Acacia species

Acacia species	**Hydrolysable tannins**	**Condensed tannins**	**Flavonoids**
decurrens	Not present	catechin gallocatechin robinetinidol fustin fisetin	rutin
implexa	gallic acid protocatechuic acid	procyanidin b2. epicatechin gallocatechin melacacidin epicatechin gallate	Rhamnetin rhamnetin, 3,30-dimethyquercetin quercetin diglucoside rutin kaempferol
mearnsii	Not present	catechin gallocatechin mollisacacidin fisetinidol robinetinidol 4′-*o*-methylrobinetinidol 3′-*o*-β-d-glucopyranoside fustin	myricitrin quercitrin taxifolin

Other compounds

The bark of *A. mearnii* is a source of pinitol, a cyclitol or polyol, which is a common sugar alcohol having antidiabetic and anti-inflammatory properties. It is a common constituent of legumes such as soybean.



D-Pinitol

Image from https://www.researchgate.net/publication/341357231

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