



## Review on Combretaceae Family

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### ABSTRACT

Combretaceae, the family of flowering plants consisting of 20 genus and 600 important species in respective genus. The two largest genera of the family are Combretum and Terminalia which contains the more no. of species. The members of the family are widely distributed in tropical and subtropical regions of the world. Most members of the trees, shrubs or lianas of the combretaceae family are widely used medicinally. The members of this family contain the different phytoconstituents of medicinal value e.g tannins, flavonoids, terpenoids and alkaloids. Most of the species of this family are used as antimicrobial, antioxidant and antifungal. The biological activities of the some members of this family yet not found. Apart from the medicinal value many members of the Combretaceae are of culinary and ornamental value.

**Keywords:** Combretaceae, Tannins, Flavonoid, Terminalia, Combretum.

### INTRODUCTION

The family combretaceae is a major group of flowering plants (Angiosperms) included in the order of Myrtales. Robert Brown established it in 1810 and its inclusion to the order is not in dispute. The family comprises of 20 genera and 600 different species of trees, shrubs and lianas. Combretum, Terminalia and Quisqualis are the largest genera of combretaceae. The species of the family are distributed mainly in the tropical and subtropical regions of the world. The members of the family range from lianas, mangroves, rarely creepers and shrubs to trees. The plants of this family are non-succulent, self-supporting or climbing.<sup>1-4</sup>

#### ▪ Distinguishing characters of combretaceae family

- Flowers usually small.
- Leaves simple, entire and petiolate.
- Ovary inferior.
- Hypanthium divided into two regions (a lower surrounding the ovary and an upper narrowed into a shorter or longer tube finished in calyx lobes).
- Trichomes long, straight, sharply pointed, unicellular with very thick walls and with a conical internal compartment at the base.
- Presence of stalked glands or glandular scales.<sup>5</sup>

#### ▪ Economic importance of combretaceae

Many species in the family have economic value. For example, several species of Anogeissus and Terminalia are valued as timber tree for African, European and American markets. These include: *T. superba*, *T. oblonga*, *T. amazonia*, *T. elliptica*, *T. cuneata*, *Anogeissus acuminata* and *A. latifolia*. Fruits of several species of Terminalia for example, *Terminalia catappa*, as well as

species of Combretum have edible kernels whereas Buchenavia species have edible succulent endocarps. Chemical constituents like tannins are also found in fruits, bark, leaves, roots and timber in buchenavia and terminalia genera. Many of the species are reputed to contain antimicrobial constituents and Terminalia species occurring in Southern Africa and Asia have exhibited substantial antifungal activity, hence they are used in traditional medicine.<sup>2</sup>

#### Distribution and habitats of combretaceae

Combretaceae occur throughout the tropics, with short extensions into warm temperate zones such as in Argentina, South Africa, Australia, Bermuda, China and in India. The two largest genera of the family, Combretum and Terminalia, occur on all continents (Combretum was not recorded in Australia until 1980). The greatest genetic diversity of the largest genus, Combretum is in Africa, and that of second largest genus, Terminalia, is in Southeast Asia, however this does not translate to center of origin, further studies are required to confirm origin of the genera. Mangrove species of Laguncularia and Conocarpus occur in coastal regions of America, Australia and Africa, while Lumintzera is distributed in Asia and Africa together with Anogeissus and Quisqualis.<sup>2</sup>

#### Cultivation and collection:

##### ▪ Terminalia arjuna

Arjuna is found as naturally growing plant in the dense forests. It is very common in Baitul, Madhya Pradesh, Dehradun and Uttarakhand. Arjuna can be successfully raised by sowing seeds or by means of stumps. The seeds take about 21 days for germination. It needs moist fertile alluvial loam rainfall in the range of 75-190 cm. It grows satisfactorily up to 45° C. The bark is collected from wild growing plants.<sup>6</sup>



**Table 1:** Taxonomical classification of some species of different generas <sup>1</sup>

Kingdom		Plantae			
Division		Angiosperm			
Class		Dicotyledons			
Order		Myrtales			
Genus	Species	Genus	Species	Genus	Species
Anogeissus	Acuminata	Buchenavia	Tetraphylla	Bucida	Bucera
	Latifolia		Huberi		Macrostachya
	Dhofarica		Amazonia		Molineti
	Sericea		Congesta		Palustris
	Pendula		Grandis		Subinermis
	Rivularis		Macrophylla		Umbellate
	Bentii		Guianensis		
	Leiocarpus		Reticulata		
Calycopteris	Flouribunda	Dansiea	Eliptica	Combretum	Indicum
	Nutans		Grandiflora		Collinum
Conocarpus	Erectus	Gyrocarpus	Americanus	Getonia	Nitida
	Sancifolius		Angustifolia		Floribunda
			Hababensis		Nutans
Guiera	Senegalensis	Strephonema	Sericeum	Laguncularia	Racemosa
			Mannii		Lutea
			Gilletii		Glabriflora
Lumnitzera	Racemosa	Thiola	Glaucocarpus	Pteleopsis	Habensis
	Littorea		Colombiana		Myrtifolia
Quisqualis	Caudata	Thiola	Nitida	Terminalia	Arjuna
	Parviflora		Gracillis		Bellirica
	Littorea		Paraguariensis		Argentea
	Densiflora		Stigmara		Catappa

#### ▪ *Anogeissus latifolia*

A plant of lowland grows in drier to moist tropical areas. It grows best in areas where annual daytime temperatures are within the range 22-23°C, but it can tolerate a temperature 7-47°C. It prefers a mean annual rainfall in the range 800-1,400mm, but tolerates a range 600-2,300mm. Trees of *Anogeissus latifolia* grows best in a deep fertile, well drained soil. It tolerates a pH range 5-7. The plant produces gummy exudates, which is collected by giving artificial incisions to the tree bark. After collection the grading of the gum is done taking into consideration the colour of the product. Light coloured gum is supposed to be superior. <sup>6-7</sup>

#### Morphology and microscopy

##### ▪ Morphology

#### Leaves

The Leaves are simple, alternate or opposite or whorled (rarely), spiral or distichous, or four ranked. The leaves

consist of dotted gland or non dotted gland, without marked odour. The lamina may be entire and the leaves are minutely stipulate or exstipulate. The leaves are coriaceous or membranous, petiole often glandular at the top and the stipules 0. The distinct feature on the lower surface is the presence of unicellular combretaceous hairs. <sup>2</sup>

Leaf anatomy: Hydathodes are either present (occasionally), or absent. Leaf lamina may be dorsiventral (usually) or centric (rarely); with secretory cavities or without secretory cavities. Secretory cavities may contain mucilage. Minor leaf veins are present without phloem transfer cells (combretum). <sup>4</sup>

#### Stem anatomy

Secretory cavities may be present or absent; with mucilage. Cork cambium present; initially deep seated, or superficial. Nodes are unicellular. Xylem with fibretracheids; with labriform fibre or without libriform. Internal phloem may be present or absent. Secondary



thickening develops from a conventional cambium ring or anomalous; from a single cambial ring. Vessels with vestured pits (usually) or without vestured pits.<sup>4</sup>

### Inflorescence, floral and seed morphology

Flowers are usually small; regular 3–8 merous; cyclic; tetracyclic, or pentacyclic and free hypanthium is present. Flowers are aggregated in 'inflorescence', in racemes, spikes and in heads. The ultimate inflorescence unit usually racemose. Perianth with distinct calyx and corolla.

Calyx: 4-5 sepals are present, rarely more, united to form a calyx tube adnate to ovary and produced beyond it; valvate, persistent.

Corolla: Petals are usually small, as many as sepals and alternating with them, either valvate or imbricate in aestivation, sometimes absent, polypetalous.

Androecium: Stamens 4, 5, 8 or 10, rarely many, usually double the number of sepals, in two whorls (when 8 or 10), filaments are curved inwards in bud, anthers bithecal, versatile; stamens when in two whorls, often obdiplostemonous.

Gynoecium: Monocarpellary; ovary inferior, 1-celled, generally angled, the angles equal in number and alternating with calyx-segments; ovules 2-5, rarely more, anatropous, pendulous from the top of the ovary on long, often united funicles; style one, long, filiform bearing a pointed, rarely a capitate stigma. The receptacle-tube bears a disc, which is sometimes hairy.<sup>4</sup>

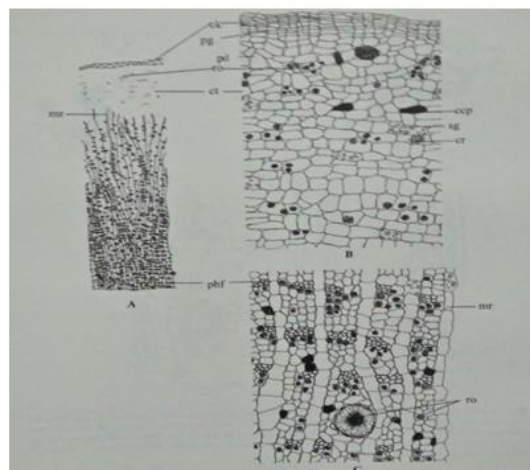
### Seeds

Seeds are non endospermic; spirally twisted cotyledons. Seedling is done by phanerocotylar or crptocotylar germination.<sup>1,7</sup>

**Fruits:** Fruits are of crucial diagnostic value in species delineation in the family. They are drupaceous or dry, usually indehiscent, often variously winged or ridged, 1-seeded pseudocarp formed from the inferior ovary and surrounded by the lower hypanthium except in the genus *Strephonema* Hook.f, where the semi-inferior ovary is positioned above the hypanthium at the stage of fruiting.<sup>1</sup>

#### Microscopy

**Stem Bark:** *Terminalia Arjuna*: Cork consists of a few layers of tangentially running and radially elongated cells, phellogen, 2-4 celled thick, phelloderm narrow, consisting of 4-6 rows of tangentially elongated and radially arranged cells. Phloem is very broad, traversed by uniseriate medullary rays running straight and parallel, occasionally becoming slightly curved near the rosette crystals; groups of phloem fibers are present with lignified, thin walled, tangentially arranged. It is associated with idioblasts containing clusters & rosettes of calcium oxalate. Some parenchymatous cells of cortex & secondary phloem contain reddish brown pigment and some cells contain starch grains.<sup>8</sup>



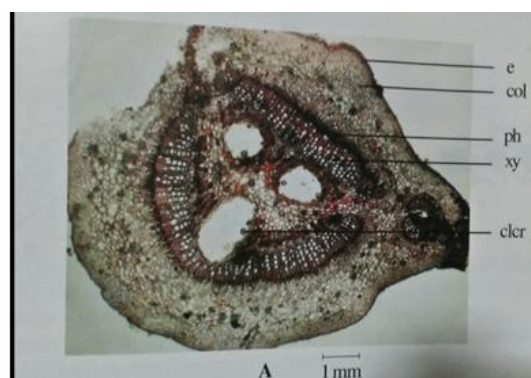
**Figure 1:** Microscopy of *Terminalia arjuna* stem bark. A. TS of *Terminalia arjuna* stem bark. B. ts of stem bark showing cork and cortex. C. TS of stem bark showing inner phloem region; ccp, cell containing pigment; ck, cork; cr, cluster of calcium oxalate crystals; ct, cortex; mr, medullary rays; pd, phelloderm; pg, phellogen; phf, phloem fibres; ro, rosette of calcium oxalate; sg, starch grains.

### Leaf

*Terminalia alata*: Diagramatic T.S. of leaf passing through the midrib is strongly convex on the lower side and narrowly elevated on the upper side and exhibit collenchymatous tissue under both epidermii. Three meristele lies in the ground tissue, the centrally located being highly well developed, oval to triangular in shape, encircling the wide pith and is embedded with cavities formed due to disintegration of the pith cells, two other meristele are very rudimentary and each one is placed at the basal region of the lateral dorsiventral laminar extensions.

**Lamina:** Shows upper and lower epidermis, the former being covered with thicker cuticle and is devoid of stomata, under the upper epidermis lies two rows of palisade cells embedded with idioblast containing rosette crystals of calcium oxalate and oil cells, remaining cells of the mesophyll are aerenchymatous traversed with cluster crystals of calcium oxalate and obliquely cut vascular bundles.

**Petiole:** The T.S. shows an outer layer of epidermis, well developed collenchymatous hypodermis and wide cortex traversing with fibres; a rudimentary vascular bundle is located under each ridged region of the section. Meristele is somewhat kidney shaped, endodermis is distinct, and pith is parenchymatous and is embedded with oval to circular big cavities. Cluster crystals of calcium oxalate traversed throughout the parenchymatous cells of the section.<sup>9</sup>







**Figure 2:** *Terminalia alata* leaf; e, epidermis; col, collenchyma; ph, phloem; xy, xylem.






### Different genus and species

Combretaceae family comprises of various genera and species. Most of the chemical constituent's present and

medicinal uses of different species are reported in literature. The following table shows some of the species along with chemical constituents and uses.

**Table 2:** Different genus with representing some plant species of Combretaceae family

S. No.	Genus	Species	Image of the Species	Parts used	Chemical constituent	Uses
1	Anogeissus	<i>Anogeissus latifolia</i>		Stem bark	Ellagic acid, L-arabinose, D-mannose, D-glucouronic acid,	Emulsifying agent, Expectorant Skin diseases, Rheumatism <sup>6</sup>
2.	Buchenavia	<i>Buchenavia tetraphylla</i>		Leaves	trans-caryophyllene, $\alpha$ -cadinol, $\alpha$ -muurolol. <sup>10</sup>	Decorative veneer, construction, boatbuilding.
3.	Bucida	<i>Bucida buccera</i>		Leaves, bark, fruit	Buceracidins A and B (flavanones), Bucidasins A-D, (diterpene).	Astringent, In fever, ornamental Purpose. <sup>11</sup>
4.	Calycopteris	<i>Calycopteris floribunda</i>		Leaves, flowers, stems, roots	Calycopterone ellagic acid, quercetin, isocalycopterone	Antioxidant, , anthelmintic, In jaundice <sup>12-14</sup>

5.	Combretum	Combretum indicum		Leaves flowers, fruits, roots	quisqualic acid, oleic acid, rutin, arachidonic acid	In rheumatism, Anthelmintic Antioxidant.
6.	Conocarpus	Conocarpus erectus		Leaves	Trimethoxyellagic acid, gallic acid	Ornamental purpose
7.	Guiera	Guiera senegalensis		Leaves, twigs, flowers, fruits	Guieranone A, 3 $\beta$ Carboline, Harman, harmalan	Protein supplement, In Beriberi, Rheumatism, eczema, Dysentery, Asthma <sup>15,16</sup>
8.	Quisqualis	Quisqualis indica		Seeds	Potassium salt of Quisqualic acid, Myristic acid, Trigonelline, Oleic acid, Linoleic acid	Anthelmintic, Ringworm disease, Rickets, Antipyretic <sup>17</sup>
9.	Terminalia	Terminalia Bellirica		Bark, Fruits	$\beta$ -sitosterol, bellericanin, gallic acid, ellagic acid	Anthelmintic, Expectorant, Digestive, Antipyretic, Skin diseases <sup>17</sup>

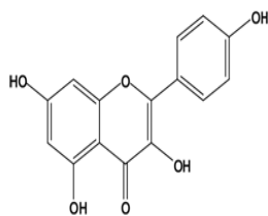
### Chemical constituents

Combretaceae is the source of a wide range tannins (e.g. ellagitannin and their derivatives), flavonoids, terpenoids (oleanoic and ursanoic acid to friedelins, cycloartanes and dammaranes) and stilbenoids. Stilbenoids from the Combretaceae have been named Combretastatins are designated A, B, C and D. combretastatin A and combretastatin B are the most common in *C. kraussi*, *C. molle*, *C. apiculatum*, *C. collinum* and leaves of *C. woodii*. The phenanthrenes are phenolic compounds with three fused rings which are found in Combretaceae<sup>3</sup>. The major compounds isolated from Combretaceae are discussed according to different genera and species as follows-

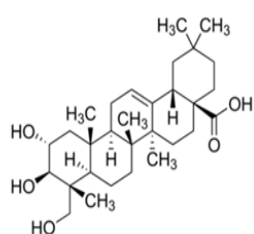
- **Genus: Combretum** : Genus combretum contains the many classes of constituents, including triterpenes, flavonoids, lignans and non-protein amino acids ,among others Since the 1970s, several

unusual compounds have also been isolated from Combretum species, for example triterpenes and their glycosides from *C. laxum*, among them, arjunolic acid, arjunglucoside II, bellericoside, chebuloside II, quadranoside IV, asiatic acid and betulinic acid. Some flavonoids, rhamnocrin, quercetin and kaempferol were isolated from *C. erythrophyllum* as well as quercetrin, kaempferol and pinocembrin (flavanone) from *C. apiculatum*. Combretastatins, a group of stilbenes are present in several species of combretum.<sup>3</sup>

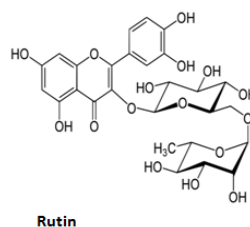
Examples of structures isolated from different species of the genus Combretum.



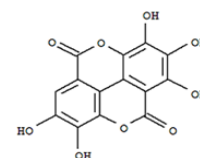
Kaempferol



Arjunolic acid

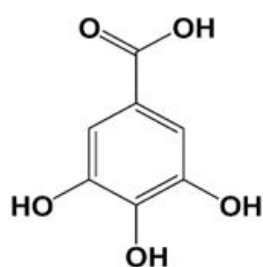


Rutin

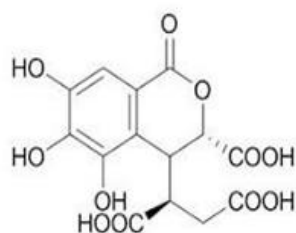


Flavellagic acid

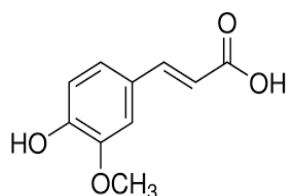
- **Genus: Terminalia:** Genus Terminalia Contains the chemical constituents such as tannins, phenolic acids, triterpenes, triterpenoidal glycosides, flavones, flavonoids, chalcones, gallic acid, ellagic acid, quercetin, kaempferol, ferulic acid, coumarins, chebolic acid, ellagitannin and simple gallate esters, lignan and lignan derivatives. Crude extracts and isolated components of different Terminalia species showed a wide spectrum of biological activities.



Gallic acid



Chebolic acid



Ferulic acid

### Genus: Anogeissus

The genus Anogeissus is characterised by the presence of phenolic compounds like tannins and flavonoids. The presence of many bioactive secondary metabolites like alkaloids, anthraquinones, essential oils, flavonoids, glycosides, saponins, steroids, tannins, terpenoids and xanthenes. These secondary metabolites are accountable for various pharmacological activities. Gum ghatti contains galactose, uronic acid and pentose. Other chemical constituent from the different species such as *A. acuminata*, *A. latifolia* and *A. leiocarpus* contains glycosides of ellagic and flavellagic acid along with quercetin, rutin, castalagin, anolignan A, B, C, anogeissinin and others. 1

### Marketed formulations

As the various species belonging to family are found to medicinally useful, the numbers of marketed formulations are available as shown in table no. 3.

**Table 3:** Marketed Formulation of some species<sup>18</sup>

Sr. No.	Dosage form	Brand name	Main herb
1.	Tablet	Kaishore Guggul Tablets Triphala Guggul tablets	<i>Terminalia chebula</i>
2.	Vati	Arogayavardhni vati Sanjivani vati	<i>Terminalia chebula</i>
3.	Capsules	Arjuna capsules Coolstrin-A capsule Triphala capsules Digestion support Capsule	<i>Terminalia arjuna</i> <i>Terminalia chebula</i> , <i>Terminalia bellerica</i>
4.	Powders	Arjuna powder Bibhitaki powder Haritaki powder	<i>Terminalia arjuna</i> <i>Terminalia bellerica</i> <i>Terminalia chebula</i>
5.	Herbal juices	Arjun saar	<i>Terminalia arjuna</i>
7.	Churna	Triphala churna Nyagrodadi churna	<i>Terminalia bellerica</i> <i>Terminalia chebula</i>
8.	adha (Decoctionform)	Asanadi Kashayam	<i>Anogeissus latifolia</i>
9.	Oil	Bala Oil	<i>Anogeissus latifolia</i>

### Uses

Members of Combretaceae provide a variety of culinary, medicinal, and ornamental values. In terms of culinary value, the most important species of this family is *Terminalia catappa*-Indian almond (Jungali badam) which is edible. Most of the members of combretaceae have medicinal activity such as antibacterial, antifungal, antioxidant and antiparasitic activity. *Quisqualis indica* (Rangoon creeper), *Terminalia Arjuna* (Arjun), *Bucida*, *Combretum* are of Ornamental value.<sup>19</sup>

**Table 4:** Different medicinal uses of some species of the family

Sr. No.	Name of the species	Medicinal use/activity	Parts of the plant
1.	<i>Anogeissus latifolia</i>	Antioxidant Used in anaemia, haemorrhoides, skin diseases. Antiulcer	Tender shoots, stem bark Stem, leaves, Bark
2.	<i>Anogeissus acuminata</i>	Used in Diarrhoea, dysentery, wound healing Diabetes, toothache.	Stem bark
3.	<i>Anogeissus leiocarpus</i>	Antibacterial	Bark
4.	<i>Combretum apiculatum</i>	Anthelmintic	Dried leaves
5.	<i>Combretum comosum</i> , <i>Combretum cuspidatum</i>	Antileishmaniasis	Dried leaves
6.	<i>Combretum acutifolium</i> , <i>Combretum imberbe</i> , <i>Combretum nigricans</i> .	Antifungal	Dried leaves
7.	<i>Combretum micranthum</i> <i>Combretum decandrum</i>	Hypoglycemic activity	Dried leaves
8.	<i>Combretum glutinosum</i>	Antitussive Abortifacient	Decoction of leaves
9.	<i>Terminalia chebula</i>	Anticarcinogenic Wound healing activity	Fruit extract

## CONCLUSION

Combretaceae family is one out of the different families of the millions of plants available in the whole world. Combretaceae is the family of the Flowering Plants having 20 genera for studying different kind of plants. Many members of this family are widely used medicinally, culinary and ornamentally. The various members of this family contain flavonoids, terpenoids, tannins and alkaloids. The therapeutic activity of the chemical compounds present in the members of this family ranges from simple antidiarrhoeal to the anticarcinogenic activity and includes antioxidant, antibacterial, antifungal, anthelmintic, hypoglycemic, antitussive and abortifacient etc. There are number of marketed formulations containing the herbs or their extracts belonging to family combretaceae.

Scope: There are several species of this family which are yet to explore of their chemical constituents and to screen them for their pharmacological activity.

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