Bombacaceae: A phytochemical review

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REVIEW ARTICLE

Bombacaceae: A phytochemical review

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Abstract

Context: Bombacaceae is a small family of the order Malvales and contains about 28 genera and 200 species. Members of this family are not only showy ornamentals but they possess significant economical and commercial reputation as well. In addition, various plant parts of several species are widely used as foods and traditional medicines in many parts of the world.

Objective: Chemical analyses of Bombacaceae species have recently yielded a number of important phytocompounds belonging to different classes. Hence, this work represents a comprehensive appraisal of the phytochemical studies conducted on Bombacaceae plants.

Materials and methods: Searches were conducted using electronic databases (e.g., Medline, Pubmed, Academic Journals, and Springer Link); general web searches were also undertaken using Google applying some related search terms "e.g., Bombacaceae, phytochemical studies of Bombacaeae plants, and chemical investigation of Bombacaeae", journals and scientific theses. The bibliographies of papers relating to the review subject were also searched for further relevant references.

Results: Chemical investigations were concentrated primarily on certain species leaving fertile fields for further phytopharmacological research.

Conclusion: The reviewed findings present Bombacaceae species as an untapped reservoir of phytocompounds which may play a supportive role in the pharmaceutical field and will be of high chemotaxonomic value within this recently separated family.

Keywords: Chemical constituents, phytochemistry

Introduction

Bombacaceae (Bombax, Baobab or Kapok family) is a small family of flowering plants which contains about 28 genera and 200 species (Joly, 1991). Plants of this family are perennial, deciduous and woody trees. They occur naturally throughout the tropical and subtropical regions of the world especially in tropical America (Benson, 1970). Many species grow to become large trees, with *Ceiba pentandra* L. Gaertn. the tallest, reaching a height of 70 m. Additionally, some of these plants have considerable girth, so called "bottle trees" and their trunks are usually with buttresses at the base (Frankham et al., 1996). Besides the great significance of Bombacaceae plants as ornamentals due to their large branches and brightly colored flowers, several genera are economically and commercially important, producing timber, edible fruits, vegetable oils or useful fibers, e.g., silk floss trees (*Chorisia* spp.) and Kapok (fibers of *Ceiba* fruits) (Perez-Arbelaez, 1956). The family is also noted for some of the softest hardwoods commercially traded, especially Balsa wood (*Ochroma lagopus* Swartz). The Baobabs (*Adansonia* spp.) are important icons in certain parts of Africa and Australia, noted for their immensely stout trunk development which is a mechanism for enhancing water storage (Paula et al., 1997). Moreover, members of Bombacaceae found several folkloric medicinal uses in many countries due to their antipyretic, analgesic, anti-inflammatory, astringent, stimulant, diuretic, and antimicrobial properties (Paula et al., 1997).

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In old classical literature of taxonomy, Bombacaceae has been considered as a taxon or subfamily under Malvaceae. However, in the majority of the recent taxonomic works, Bombacaceae has been treated as an independent family of the order Malvales (Cronquist, 1981; Heywood et al. 2007). In several anatomical and floral characters, Bombacaceae shows close affinities with Malvaceae. However, many of its genera show a close relationship with Dilleniaceae on the basis of their stamen morphology. Bombacaceae differs from Malvaceae in (i) being exclusively arborescent (woody trees), (ii) often possessing a prickly trunk, (iii) bearing dithecous anthers (bi-chambered) in some and monothecous in others, and (iv) always having smooth pollen grains (Sharma, 1993). Additionally, Cronquist (1981) shows a close relationship of Bombacaceae with Malvaceae, Sterculiaceae, and Tiliaceae.

Phytochemical studies

Phytochemical investigations of various parts of Bombacaceae plants resulted in the isolation of several diverse classes of compounds (Table 1 and Figure 1). From the data available in the literature, it can be observed there is apparently no relationship between the genera studied from the phytochemical point of view. However, this does not necessarily result in questioning of the botanical classification of the species of this family. This relationship cannot be observed among species of the same genus, mainly because from most of them, only few numbers were studied (Paula et al., 1997). *Adansonia, Bombax ceiba* (syn. *Bombax malabaricum, Bombax malabarica, Salmalia malabaricum, Gossampinus malabarica*), *Ceiba pentandra* (syn. *Bombax pentandrum*), *Chorisia, Ochroma, Pachira* (syn. *Bombacopsis*), *Pseudobombax* and *Quararibea* are the most studied members. It is worth mentioning that the genus *Durio* (included in the review by Paula et al., 1997) was excluded from Bombacaceae after Heywood et al. (2007). Accordingly, this work represents an up-to-date comprehensive account on various classes of the isolated active principles from Bombacaceae plants together with their structural and stereochemical differences. In addition, their distribution in different plant parts of various species studied so far is also completely considered.

In addition to the compounds mentioned in Table 1, the volatile constituents of some Bombacaceae plants were analyzed using GC/MS technique and several compounds belonging to different structural types were identified as follows.

The volatile oil of *Adansonia digitata* L. flowers was found to contain isoprenoids including: monoterpene hydrocarbons (0.6%) [e.g. *(E)*-ocimene (0.6%)], oxygenated monoterpenes (0.2%) [e.g. linalool (0.2%)], and irregular terpenes (21.1 %) [e.g. 6-methyl-5-hepten-2-ol (0.7%), 2-methyl-butanal (1%), 3-methylbutanal (16.3%), *(E)*-2-methyl-2-butenal (2.1%), 3-methyl-1-butanol (1.8%)], fatty acid derivatives (13%) including: [nonane (1.2%), 3-pentanone (1.4%), decane (0.5%), 3-pentanol (3.6%), butanol (1.7%), 1-penten-3-ol (2.2%), 2-heptanone (0.2%), 2-hexenal (1.7%), 3-hydroxy-2-butanone (0.6%)], benzenoids (7.8%) including: [benzaldehyde (7.8%)], and sulphur compounds (15.3%) including: [methyl thioacetate (1.4%), dimethyl disulphide (10.3%), methyl thiobutanoate (0.8%), methyl 3-methylbutan-ethioate (1.9%), dimethyl trisulphide (0.4%), methyl thiohexanoate (0.6%)]. On the other hand, the oil was free from sesquiterpene hydrocarbons and nitrogenous compounds (Pettersson et al., 2004).

Similarly, the volatile oil of *Ceiba pentandra* L. flowers was found to contain isoprenoids including: monoterpene hydrocarbons (34%) [e.g. α-pinene (7.1%), β-pinene (3.4%), sabinene (20.8%), α-phellandrene (0.9%), limonene (0.7%), *p*-cymene (1.2%)], oxygenated monoterpenes (8.4%) [e.g. 1,8-cineole (5.3%), *trans*-sabinene hydrate (1%), *cis*-sabinene hydrate (0.6%), terpinen-4-ol (0.5%), verbenone (0.9%)], and sesquiterpene hydrocarbons (26.9%) [e.g. α-copaene (5.5%), (*E*,*E*)-α-farnesene (20.3%)], fatty acid derivatives (18.1%) including: [3-pentanol (1%), 1-penten-3-ol (0.5%), 2-hexenal (8.9%), (*Z*)-3-hexenol (1.1%), 1-octen-3-ol (4.1%), pentanoic acid (2.5%)], benzenoids (7.8%) including: [benzaldehyde (1.9%), methyl benzoate (1.6%), 1-methoxy-4-(2-propenyl)-benzene (0.4%), methyl salicylate (1.8%), benzyl alcohol (1.8%), 2-phenyl ethanol (0.3%), 4-methoxy benzaldehyde (0.4%)], and miscellaneous compounds (2%) [e.g. 5-ethyl-2(5*H*)-furanone (2%)]. On the other hand, the oil was free from sulphur and nitrogen-containing compounds (Pettersson et al., 2004).

Moreover, the volatile oil of *Eriotheca longitubulosa* A. Robyns flowers was found to contain monoterpenes including [*trans*-ocimene (9.87%), limonene (1.67%), linalool (0.52%), camphor (0.48%), δ-cadinene (0.11%)]; sesquiterpenes including [α-farnesene (28.03%), germacrene-D (25.68%), caryophyllene (0.69%), germacrene-A (0.37%)]; irregular terpenes including [4,8,12-trime-1,3(*E*),7(*E*),11-tridecatetraene (1.2%)]; fatty acid derivatives including [*cis*-3-hexenol (0.63%), *n*-nonanal (1.85%), 6-methyl-3-heptanol (1.60%), 1-hepten-3-ol (1.13%), *n*-hexanal (0.64%), *n*-heptanal (0.36%), heptadecane (0.29%), undecane (0.16%), dodecane (0.15%), *n*-octadecane (0.14%)], benzenoids including: [toluene (6.92%), salicylaldehyde (2.24%), benzaldehyde (0.55%), naphthalene (0.48%), *O*-xylol (0.25%), phenol (0.93%), methyl salicylate (0.15%), acetophenone (0.15%)]; *N*-containing compounds including: [pyridine (0.94%)]; other miscellaneous compounds including cyclopentanone (0.27%), methyl senecioate (2.10%), hexenyl valerate (1.03%), 2-methyl-2-butensre-methyl (0.90%), methyl-2-methyl-butyrate (0.76%), *cis*-3-hexenyl-butyrate (0.59%), ethyl *n*-amyl ketone (3.17%), δ-3-carene (0.3%), *(E,E)*-2,6-*Dime*-1,3,5,7-octatetraene (0.26%), *cis*-3-hexenyl senecioate

Table 1. A list of compounds isolated from family Bombacaceae.

No.	Compound	Plant Source	Part	Ref.
A) Flavonoids:				
1) Flavanols:				
1	(+)-Catechin	*Ceiba pentandra*	Stem bark	Noreen et al., (1998)
		Ochroma pyramidale	Leaf	Vazquez et al., (2001)
2	(-)-Epicatechin	*Adansonia digitata*	Fruit	Shahat, (2006)
		Ochroma pyramidale	Leaf	Vazquez et al., (2001)
3	5,7,3', 4'-Tetrahydroxy-6-methoxy-flavan-3-*O*-β-D-glucopyranosyl-(1→ 4)-α-D-xylopyranoside	*Bombax ceiba*	Root	Chauhan et al., (1980)
4	Shamimicin	*Bombax ceiba*	Stem bark	Saleem et al., (2003)
2) Flavanones:				
5	Hesperidin (5,3'-dihydroxy-4'-methoxy-flavan-7-*O*-α-L-rhamnopyranosyl-(1→ 6)-β-D-lucopyranoside	*Bombax ceiba*	Root	Qi et al., (1996)
6	3,3',4'-Trihydroxy flavan-4-one-7-O-α-L-rhamnopyranoside.	*Adansonia digitata*	Root	Chauhan et al., (1987) Shahat, (2006)
3) Flavanonols:				
7	3,7-Dihydroxy-flavan-4-one-5-*O*-β-D-galactopyranosyl-(1→ 4)-β-D-glucopyranoside	*Adansonia digitata*	Root	Chauhan et al., (1984)
4) Flavones:				
8	Apigenin	*Bombax ceiba*	Flower	El-Hagrassi et al., (2011)
		Chorisia crispiflora	Flower	Hassan, (2009)
9	Apigenin-7-*O*-β-D-rutinoside	*Chorisia insignis*	Leaf	El-Alfy et al., (2010)
10	Apigenin-8-C-β-D-glucopyranoside (vitexin)	*Ochroma pyramidale*	Leaf	Vazquez et al., (2001)
11	Cosmetin	*Bombax ceiba*	Flower	El-Hagrassi et al., (2011)
12	5-Hydroxy-7,4'-dimethoxy-flavone	*Bombax anceps*	Root	Sichaem et al., (2010)
13	5-Hydroxy-3,7,4'-trimethoxy- flavone	*Bombacopsis glabra*	Stem bark, Root bark	Paula & Cruz, (2006)
		Bombax anceps	Root	Sichaem et al., (2010)
14	5-Hydroxy-3,6,7,4'-tetra-methoxy-flavone	*Bombacopsis glabra*	Stem bark, Root bark	Paula & Cruz (2006)
15	5-Hydroxy-3,6,7,8,4'-penta-methoxy-flavone	*Bombacopsis glabra*	Stem bark	Paula et al., (2002)
16	Isovitexin	*Bombax ceiba*	Flower	El-Hagrassi et al., (2011)
17	Linarin	*Bombax ceiba*	Flower	El-Hagrassi et al., (2011)
18	Luteolin	*Chorisia crispiflora*	Flower	Hassan, (2009)
19	Luteolin-7-*O*-β-D-glucoside	*Chorisia crispiflora*	Flower	Hassan, (2009)
20	5,7-Dimethoxy-flavone	*Bombax anceps*	Root	Sichaem et al., (2010)
21	3,5,7-Trimethoxy-flavone	*Bombax anceps*	Root	Sichaem et al., (2010)
22	Luteolin-7-*O*-neohesperidoside	*Chorisia crispiflora*	Leaf, Flower	Hassan, (2009)
23	Luteolin-7-*O*-β-D-rutinoside	*Chorisia insignis*	Leaf	El-Alfy et al., (2010)
24	Rhoifolin	*Chorisia crispiflora*	Leaf, Flower	Coussio, (1964) Hassan, (2009)
		Chorisia insignis	Leaf	Coussio, (1964)
		Chorisia pubiflora	Leaf	Coussio, (1964)
		Chorisia speciosa	Leaf, Flower	Coussio, (1964) Hafez et al., (2003)
25	Saponarin	*Bombax ceiba*	Flower	El-Hagrassi et al., (2011)
26	Tricin	*Chorisia crispiflora*	Flower	Hassan, (2009)
27	Vicenin 2	*Bombax ceiba*	Flower	El-Hagrassi et al., (2011)
28	Xanthomicrol	*Bombax ceiba*	Flower	El-Hagrassi et al., (2011)

(Continued)

Table 1. *(Continued)*.

No.	Compound	Plant Source	Part	Ref.
5) Isoflavones:				
29	5-Hydroxy-7,4′,5′-trimethoxy isoflavone-3′-*O*-α-L-arabinofuranosyl(1→6)-β-D-glucopyranoside.	*Ceiba pentandra*	Stem bark	Ueda et al., (2002)
30	Vavain (Pentandrin) (5,3′-dihydroxy-7,4′,5′-trimethoxy isoflavone)	*Ceiba pentandra*	Stem bark	Noreen et al., (1998); Ngounoua et al., (2000); Ueda et al., (2002)
31	Vavain-3′-*O*-β-D-glucopyranoside (Pentandrin glucoside)	*Ceiba pentandra*	Stem bark	Noreen et al., (1998); Ngounoua et al., (2000); Ueda et al., (2002)
6) Flavonols:				
32	3,5-Dihydroxy-4'-methoxy-flavon-7-yl-*O*-α-L-rhamnopyranosyl-(1→6)-β-D-glucopyranoside	*Bombax ceiba*	Flower	Rizvi & Saxena, (1974)
33	Kaempferol	*Bombax ceiba*	Flower	Gopal & Gupta, (1972)
		Ceiba pentandra	----	Bravo et al., (2002)
34	Quercetin	*Bombax ceiba*	Flower	Gopal & Gupta, (1972)
		Ceiba pentandra	----	Bravo et al., (2002)
		Chorisia speciosa	Flower	Hafez et al., (2003)
35	Quercetin-3-O-β-D-glucoside	*Adansonia digitata*	Fruit	Shahat, (2006)
36	Quercetin-7-*O*-β-D-xylopyranoside	*Adansonia digitata*	Stem	Chauhan et al., (1982)
			Root	Shukla et al., (2001)
37	Rutin	*Chorisia insignis*	Leaf	El-Alfy et al., (2010)
38	Shamimin (2-(2,4,5-trihydroxyphenyl)-3,5,7-trihydroxy-6-C- glucopyranosyloxy-4*H*-1-benzopyran-4-one)	*Bombax ceiba*	Leaf	Faizi & Ali, (1999); Saleem et al., (1999)
39	Tiliroside (kaempferol-3-*O*-β-D-(6″-*p*-coumaroyl)-glucoside	*Chorisia crispiflora*	Flower	Hassan, (2009)
		Chorisia speciosa	Flower	Hafez et al., (2003)
40	4',5,7-Trihydroxy-flavon-3-yl-*O*-β-D-glucopyranosyl-(1→4)-α-L-rhamnopyranoside	*Bombax ceiba*	Flower	Haq & Gomes, (1973)
41	3',4',5'-Trihydroxy-6-methoxy flavone-3-*O*-glucopyranoside	*Bombax ceiba*	Flower	Rizk, & Al-Nowaihi, (1989)
B) Anthocyanidins and anthocyanins:				
42	Cyanidin-3-glucoside	*Ceiba acuminate*	Flower	Scogin, (1986)
		Chorisia speciosa	Flower	Scogin, (1986)
		Ochroma Lagopus	Calyx	Scogin, (1986)
		Pachira aquatica	Flower	Scogin, (1986)
43	Cyanidin-3,5-diglucoside	*Bombax ceiba*	Flower	Scogin, (1986)
		Chorisia speciosa	Flower	Scogin, (1986)
		Pseudobombax ellipticum	Flower	Scogin, (1986)
		Pseudobombax grandiflorum	Flower	Scogin, (1986)
44	Cyanidin-7-methyl ether-3-β-D-glucoside	*Bombax ceiba*	Flower	Niranjan & Gupta, (1973)
45	Cyanidin-3-rutinoside	*Pachira aquatica*	Flower	Scogin, (1986)
46	Pelargonidin-5-β-D-glucoside	*Bombax ceiba*	Flower	Niranjan & Gupta, (1973)
47	Pelargonidin-3,5-diglucoside	*Bombax ceiba*	Flower	Rizk & Al-Nowaihi, (1989)
C) Xanthones glycosides:				
48	2-*C*-β-D-glucopyranosyl-1,6,7-trihydroxy-3-*O*-(*p*-hydroxybenzoyl)-9*H*-xanthen-9-one	*Bombax ceiba*	Leaf	Versiani, (2004)

(Continued)

Table 1. *(Continued)*.

No.	Compound	Plant Source	Part	Ref.
49	4-*C*-β-D-Glucopyranosyl-1,6,8-trihydroxy-3,7-di-*O*-(*p*-hydroxybenzoyl)-9*H*-xanthen-9-one	*Bombax ceiba*	Leaf	Versiani, (2004)
50	2-*C*-β-D-Glucopyranosyl-1,3,6, 7-tetrahydroxy-9*H*-xanthen-9-one(Mangiferin)	*Bombax ceiba*	Leaf	Versiani, (2004)
51	4-*C*-β-D-Glucopyranosyl-1,3,6, 8-tetrahydroxy-7-*O*-(*p*-hydroxybenzoyl)-9*H*-xanthen-9-one	*Bombax ceiba*	Leaf	Versiani, (2004)
D) Quinones and naphthoquinones:				
52	Bombaxquinone B (isohemigossypolone-2-methyl ether)	*Bombax anceps*	Root	Sichaem et al., (2010)
		Bombax ceiba	Root	Sankaram et al., (1981); Zhang et al., (2007)
			Root bark	Bell et al., (1978); Reddy et al., (2003)
		Ceiba pentandra	Root bark	Rao et al., (1993); Kishore et al., (2003)
53	Isohemigossypolone (2,7-dihydroxy-8-formyl-5-isopropyl-3-methyl-1,4-naphthoquinone)	*Bombacopsis glabra*	Stem bark, Root bark	Paula & Cruz (2006)
		Bombax ceiba	Root	Seshadri et al., (1971); (1973)
		Bombax ceiba	Root bark	Bell et al., (1978)
		Ceiba pentandra	Heart wood	Kishore et al., (2003)
		Pachira aquatica	Root bark	Shibatani et al., (1999); Paula et al., (2006)
54	Isohemigossypolone-2-methyl ether	*Pachira aquatica*	Root bark	Shibatani et al., (1999a)
55	11-nor-isohemigossypolone-2-methyl ether (7- hydroxy-5-isopropyl-2-methoxy-3-methyl-1,4-naphthoquinone	*Bombax ceiba*	Heart Wood	Puckhaber & Stipanovic, (2001)
		Pachira aquatica	Stem bark	Shibatani et al., (1999b)
56	Hemigossypolone	*Bombax ceiba*	Root bark	Seshadri et al., (1971)
57	Hemigossypolon-6-methyl ether	*Bombax ceiba*	Root bark	Seshadri et al., (1971); Bell et al., (1978)
E) Sesquiterpenes:				
58	Aquatidial	*Pachira aquatica*	Root bark	Paula et al., (2006)
59	Bombamalone A	*Bombax ceiba*	Root	Zhang et al., (2007)
60	Bombamalone B	*Bombax ceiba*	Root	Zhang et al., (2007)
61	Bombamalone C	*Bombax ceiba*	Root	Zhang et al., (2007)
62	Bombamalone D	*Bombax ceiba*	Root	Zhang et al., (2007)
63	Bombamaloside	*Bombax ceiba*	Root	Zhang et al., (2007)
64	Gossypol	*Bombax ceiba*	Root bark	Seshadri et al., (1976)
65	Hemigossypol	*Bombax ceiba*	Root bark	Seshadri et al., (1973)
66	Hemigossypol-6-methyl ether	*Bombax ceiba*	Root bark	Seshadri et al., (1973)
67	Hemigossypol-1,6,7- trimethyl ether	*Bombax ceiba*	Root bark	Seshadri et al., (1973)
68	7-hydroxy-cadalene	*Bombax ceiba*	Root	Sankaram et al., (1981)
	(5-isopropyl-3,8-dimethyl-2-naphthol)	*Bombax pentandrum*	---	Rao et al.,(1993)
		Ceiba pentandra	Root bark	Rao et al., (1993)
69	Isohemigossypol	*Bombax ceiba*	Root bark	Seshadri et al., (1976)
70	Isohemigossypol-1-methyl ether	*Bombax anceps*	Root	Sichaem et al., (2010)

(Continued)

Table 1. *(Continued)*.

No.	Compound	Plant Source	Part	Ref.
		Bombax ceiba	Root bark	Sankaram et al., (1981); Puckhaber & Stipanovic, (2001); Zhang et al., (2007)
71	Isohemigossypol-2-methyl ether	*Bombax anceps*	Root	Sichaem et al., (2010)
		Bombax ceiba	Root, Root bark	Seshadri et al., (1973) Sankaram et al., (1981); Puckhaber & Stipanovic, (2001)
72	Isohemigossypol-1,2-dimethyl ether	*Bombax ceiba*	Root, Root bark	Sankaram et al., (1981) Puckhaber & Stipanovic, (2001)
73	Isohemigossypol-2,7-dimethyl ether	*Bombax ceiba*	Root	Sankaram et al., (1981)
74	Lacinilene C	*Bombax ceiba*	Root	Zhang et al., (2007)
F) Sesquiterpene lactones:				
75	Hemigossylic acid lactone-2-hydroxy-7-methyl ether	*Bombax ceiba*	Root	Sankaram et al., (1981)
		Ceiba pentandra	Root bark	Rao et al., (1993)
76	6-Hydroxy-5-isopropyl-3-methyl-7-methoxy-8,1-naphthalene carbolactone	*Bombax ceiba*	Root	Sood et al., (1982)
77	Isohemigossylic acid lactone-2-methyl ether	*Bombax ceiba*	Root	Puckhaber & Stipanovic, (2001); Zhang et al., (2007)
		Ceiba pentandra	Root Bark	Rao et al., (1993)
78	5-Isopropyl-3-methyl-2,7-dimethoxy-8,1-naphthalene carbolactone	*Bombax ceiba*	Root	Sankaram et al., (1981)
		Ceiba pentandra	Root Bark	Rao et al., (1993)
79	5-Isopropyl-3-methyl-2,4,7-trimethoxy-8,1-naphthalene carbolactone	*Bombax ceiba*	Root bark	Reddy et al., (2003)
G) Triterpenes:				
80	α-Amyrin	*Adansonia digitata*	Fruit	Sipra-Dan & Dan, (1986)
		Bombax ceiba	Flower	EL-Hagrassi et al., (2011)
81	β-Amyrin palmitate	*Adansonia digitata*	Fruit	Al-Qarawi et al., (2003)
82	β-Amyrone	*Chorisia crispiflora*	Leaf	Hassan, (2009)
83	9,19-Cyclolanost-23-ene-3β,25-diol	*Bombacopsis glabra*	Stem Bark	Paula et al., (2002)
84	(24*R*)-9,19-Cyclolanost-25-ene-3β,24-diol	*Bombacopsis glabra*	Stem Bark	Paula et al., (2002)
85	(24*S*)-9,19-Cyclolanost-25-ene-3β,24-diol	*Bombacopsis glabra*	Stem Bark	Paula et al., (2002)
86	Friedelin	*Chorisia crispiflora*	Leaf	Hassan, (2009)
87	3β-Friedelinol	*Chorisia crispiflora*	Leaf	Hassan, (2009)
88	Lupeol	*Bombacopsis glabra*	Stem Bark	Paula & Cruz, (2006)
			Root Bark	Paula & Cruz, (2006)
		Bombax anceps	Root	Sichaem et al., (2010)
		Bombax ceiba	Root Bark,	Seshadri et al., (1971)
			Stem	Mukherjee & Roy, (1971); Versiani, (2004)
		Bombax ceiba	Bark	Saleem et al., (2003)
		Cavanillesia hylogeiton	Stem Bark	Bravo et al., (2002)
		Ochroma pyramidale	Leaf	Vazquez et al., (2001)
		Pachira aquatica	Root Bark	Paula et al., (2006)
89	Lupenone	*Bombacopsis glabra*	Stem Bark	Paula et al., (2002)
90	Oleanolic acid	*Bombax ceiba*	Root	Qi et al., (1996)
		Ochroma pyramidale	Leaf	Vazquez et al., (2001)
91	Ursolic acid	*Adansonia digitata*	Fruit	Sipra-Dan & Dan, (1986)

(Continued)

Table 1. *(Continued)*.

No.	Compound	Plant Source	Part	Ref.
H) Steroids:				
92	Δ^7-Avenasterol	*Adansonia digitata*	Seed	Bianchini et al., (1982)
	(24-Ethylidene-7-cholesten-3β-ol)	*A. fony*	Seed	Bianchini et al., (1982)
		A. grandidieri	Seed	Bianchini et al., (1982)
		A. madagascariensis	Seed	Bianchini et al., (1982)
		A. suarezensis	Seed	Bianchini et al., (1982)
		A. za	Seed	Bianchini et al., (1982)
93	Brassicasterol	*Chorisia insignis*	Seed	Hassan, (2009)
		Chorisia speciosa	Seed	Hassan, (2009)
94	Campesterol	*Adansonia digitata*	Seed	Bianchini et al., (1982)
	(24-Methyl-cholesterol)	*A. fony*	Seed	Bianchini et al., (1982)
		A. grandidieri	Seed	Bianchini et al., (1982)
		A. madagascariensis	Seed	Bianchini et al., (1982)
		A. suarezensis	Seed	Bianchini et al., (1982)
		A. za	Seed	Bianchini et al., (1982)
		Bombax ceiba	Flowers	EL-Hagrassi et al., (2011)
		Chorisia insignis	Seed	Hassan, (2009)
		Chorisia speciosa	Seed	Hassan, (2009)
95	Cholesterol	*Adansonia digitata*	Seed	Bianchini et al., (1982)
		A. fony	Seed	Bianchini et al., (1982)
		A. grandidieri	Seed	Bianchini et al., (1982)
		A. madagascariensis	Seed	Bianchini et al., (1982)
		A. suarezensis	Seed	Bianchini et al., (1982)
		A. za	Seed	Bianchini et al., (1982)
		Bombax anceps	Root	Sichaem et al., (2010)
		Bombax ceiba	Flower	EL-Hagrassi et al.,(2011)
		Chorisia insignis	Seed	Hassan, (2009)
		Chorisia speciosa	Seed	Hassan, (2009)
96	Cholestenone	*Bombax anceps*	Root	Sichaem et al., (2010)
97	24-Ethylcholesta-1,3,5-triene	*Chorisia insignis*	Seed	Hassan, (2009)
		Chorisia speciosa	Seed	Hassan, (2009)
98	24β-Ethylcholest-5-en-3β-yl-*O*-α-L-arabinosyl-(1→6)-β-D-glucopyranoside	*Bombax ceiba*	Flower	Rizvi & Saxena, (1974)
99	Isofucosterol	*Adansonia digitata*	Seed	Bianchini et al., (1982)
	(24-ethylidene-cholesterol)	*A. fony*	Seed	Bianchini et al., (1982)
		A. grandidieri	Seed	Bianchini et al., (1982)
		A. madagascariensis	Seed	Bianchini et al., (1982)
		A. suarezensis	Seed	Bianchini et al., (1982)
		A. za	Seed	Bianchini et al., (1982)
100	β-Sitosterol	*Adansonia digitata*	Seed,	Bianchini et al., (1982)
	(21-ethyl-cholesterol)		Fruit	Ramesh, et al., (1992)
		A. fony	Seed	Bianchini et al., (1982)
		A. grandidieri	Seed	Bianchini et al., (1982)
		A. madagascariensis	Seed	Bianchini et al., (1982)
		A. suarezensis	Seed	Bianchini et al., (1982)
		A. za	Seed	Bianchini et al., (1982)
		Bombacopsis glabra	Stem Bark	Paula & Cruz, (2006)
			Root Bark	Paula & Cruz, (2006)
		Bombax ceiba	Stem Bark	Mukherjee & Roy, (1971); Seshadri et al., (1971)
			Root Bark	Gopal & Gupta, (1972)
			Root	Chauhan et al., (1980)
			Flower	Seshadri et al., (1973)
		Cavanillesia hylogeiton	Stem Bark	Bravo et al., (2002)

(Continued)

Table 1. *(Continued)*.

No.	Compound	Plant Source	Part	Ref.
		Ceiba pentandra	Stem Bark	Ngounoua et al., (2000)
		Chorisia crispiflora	Leaf	Hassan, (2009)
		Chorisia insignis	Seed	Hassan, (2009)
		Chorisia speciosa	Seed	Hassan, (2009)
		Ochroma lagopus	Heart Wood	Paula et al., (1996)
		Ochroma pyramidale	Leaf	Vazquez et al., (2001)
101	β-Sitosterone	*Cavanillesia hylogeiton*	Stem Bark	Bravo et al., (2002)
102	β-Sitosterol-3-*O*-*β*-D-glucopyranoside (daucosterol)	*Bombax ceiba*	Flower	Gopal & Gupta, (1972)
			Root	Qi et al., (1996)
		Cavanillesia hylogeiton	Stem Bark	Bravo et al., (2002)
		Ceiba pentandra	Stem Bark	Ngounoua et al., (2000)
		Chorisia crispiflora	Leaf	Hassan, (2009)
		Ochroma pyramidale	Leaf	Vazquez et al., (2001)
103	Stigmasterol (24-ethyl-5,22-cholestadien-3*β*-ol)	*Adansonia digitata*	Seed	Bianchini et al., (1982)
		A. fony	Seed	Bianchini et al., (1982)
		A. grandidieri	Seed	Bianchini et al., (1982)
		A. madagascariensis	Seed	Bianchini et al., (1982)
		A. suarezensis	Seed	Bianchini et al., (1982)
		A. za	Seed	Bianchini et al., (1982)
		Bombacopsis glabra	Root, Stem Bark	Paula & Cruz, (2006)
		Bombax ceiba	Flower	EL-Hagrassi et al.,(2011)
		Chorisia insignis	Seed	Hassan, (2009)
		Chorisia speciosa	Seed	Hassan, (2009)
		Ochroma lagopus	Heart Wood	Paula et al., (1996)
		Ochroma pyramidale	Leaf	Vazquez et al., (2001)
104	Δ^7-Stigmasterol (24-ethyl-7-cholesten-3-ol)	*Adansonia digitata*	Seed	Bianchini et al., (1982)
		A. fony	Seed	Bianchini et al., (1982)
		A. grandidieri	Seed	Bianchini et al., (1982)
		A. madagascariensis	Seed	Bianchini et al., (1982)
		A. suarezensis	Seed	Bianchini et al., (1982)
		A. za	Seed	Bianchini et al., (1982)
105	Stigmast-3,5-dien-7-one	*Chorisia insignis*	Seed	Hassan, (2009)
		Chorisia speciosa	Seed	Hassan, (2009)
106	Stigmast-4-ene-3-one	*Chorisia insignis*	Seed	Hassan, (2009)
		Chorisia speciosa	Seed	Hassan, (2009)
107	Stigmast-4,6-dien-3-one	*Chorisia insignis*	Seed	Hassan, (2009)
		Chorisia speciosa	Seed	Hassan, (2009)
108	Stigmast-4-ene-3,6- dione	*Chorisia insignis*	Seed	Hassan, (2009)
		Chorisia speciosa	Seed	Hassan, (2009)
I) Lignans and neolignans:				
109	Boehmenan	*Ochroma lagopus*	Heart Wood	Paula et al., (1996)
110	Boehmenan B	*Ochroma lagopus*	Heart Wood	Paula et al., (1995)
111	Boehmenan C	*Ochroma lagopus*	Heart Wood	Paula et al., (1995)
112	Boehmenan D	*Ochroma lagopus*	Heart Wood	Paula et al., (1995)
113	Carolignan A	*Ochroma lagopus*	Heart Wood	Paula et al., (1995)
114	Carolignan B	*Ochroma lagopus*	Heart Wood	Paula et al., (1995)
115	Carolignan C	*Ochroma lagopus*	Heart Wood	Paula et al., (1995)
116	Carolignan D	*Ochroma lagopus*	Heart Wood	Paula et al., (1995)
117	Carolignan E	*Ochroma lagopus*	Heart Wood	Paula et al., (1995)
118	Carolignan F	*Ochroma lagopus*	Heart Wood	Paula et al., (1995)
119	Secoisolariciresinol diferulate	*Ochroma lagopus*	Heart Wood	Paula et al., (1996)
120	Bombasin	*Bombax ceiba*	Flower	Wu et al., (2008)
121	Bombasin-4-*O*-*β*-glucoside	*Bombax ceiba*	Flower	Wu et al., (2008)

(Continued)

Table 1. *(Continued)*.

No.	Compound	Plant Source	Part	Ref.
122	Dihydro-dehydro-diconiferyl alcohol- 4-*O*-*β*-D-glucopyranoside	*Bombax ceiba*	Flower	Wu et al., (2008)
J) Alkaloids:				
123	Adansonin	*Adansonia digitata*	Stem Bark	Osman, (2004)
124	Funebral	*Quararibea funebris*	Flower	Zennie et al., (1986)
125	Funebradiol	*Quararibea funebris*	Flower	Zennie & Cassady, (1990)
126	Funebrine	*Quararibea funebris*	Flower	Raffauf et al., (1984)
K) Coumarins:				
127	Cleomiscosine A	*Ochroma lagopus*	Heart Wood	Paula et al., (1996)
128	Scopoletin	*Ochroma lagopus*	Heart Wood	Paula et al., (1996)
L) Tannins:				
129	Gallic acid	*Bombax ceiba*	Seed	Dhar & Munjal, (1976)
130	Ethyl gallate	*Bombax ceiba*	Seed	Dhar & Munjal, (1976)
131	1-Galloyl-*β*-D-glucose	*Bombax ceiba*	Seed	Dhar & Munjal, (1976)
132	Tannic acid	*Bombax ceiba*	Seed	Dhar & Munjal, (1976)
133	Condensed tannins	*Adansonia digitata*	Leaf	Odukoya et al., (2009)
		Chorisia speciosa	----	Saleh et al., (1969)
134	Epicatechin-(4β→8)-epicatechin	*Adansonia digitata*	Fruit	Shahat, (2006)
135	Epicatechin-(4β→6)-epicatechin	*Adansonia digitata*	Fruit	Shahat, (2006)
136	Epicatechin-(2β→O→7, 4β→8)-epicatechin	*Adansonia digitata*	Fruit	Shahat, (2006)
137	Epicatechin-(4→β8)-epicatechin-(4→β8)-epicatechin	*Adansonia digitata*	Fruit	Shahat, (2006)
M) Long chain hydrocarbons, tocopherols and carotenoids:				
138	Long chain alkanes C_{12}-C_{35}	*Adansonia digitata*	Seed	Bianchini et al., (1982)
		A. fony	Seed	Bianchini et al., (1982)
		A. grandidieri	Seed	Bianchini et al., (1982)
		A. madagascariensis	Seed	Bianchini et al., (1982)
		A. suarezensis	Seed	Bianchini et al., (1982)
		A. za	Seed	Bianchini et al., (1982)
139	n-Hentriacontane	*Bombax ceiba*	Flower	Gopal & Gupta, (1972)
140	Squalene	*Adansonia digitata*	Seed	Bianchini et al., (1982)
		A. fony	Seed	Bianchini et al., (1982)
		A. grandidieri	Seed	Bianchini et al., (1982)
		A. madagascariensis	Seed	Bianchini et al., (1982)
		A. suarezensis	Seed	Bianchini et al., (1982)
		A. za	Seed	Bianchini et al., (1982)
141	Carotenoids	*Bombax ceiba*	Seed	Dhar & Munjal, (1976)
142:145	α*-, β-, γ-, δ-Tocopherols	*Adansonia digitata*	Seed	Bianchini et al., (1982)
		*A. fony**	Seed	Bianchini et al., (1982)
		A. grandidieri	Seed	Bianchini et al., (1982)
		A. madagascariensis	Seed	Bianchini et al., (1982)
		A. suarezensis	Seed	Bianchini et al., (1982)
		*A. za**	Seed	Bianchini et al., (1982)
		Bombax ceiba	Seed	Dhar & Munjal, (1976)
N) Alcohols, aldehydes, ketones, acids and esters:				
146	α-Cedrol	*Bombax ceiba*	Flower	Versiani, (2004)
147	β-Cedrol	*Bombax ceiba*	Flower	Versiani, (2004)
148	Hexacosanol	*Bombax ceiba*	Seed	Dhar & Munjal, (1976)
149	Triacontanol	*Bombax ceiba*	Root	Chauhan et al., (1980)
		Chorisia crispiflora	Leaf	Hassan, (2009)
150	Hentriacontanol	*Bombax ceiba*	Flower	Gopal & Gupta, (1972)
151	Triacontyl-*p*-coumarate	*Pachira aquatica*	Root Bark	Paula et al., (2006)
		Bombacopsis glabra	Stem Bark	Paula & Cruz, (2006)
			Root Bark	Paula & Cruz, (2006)

(Continued)

Table 1. *(Continued)*.

No.	Compound	Plant Source	Part	Ref.
152	Mannitol	*Ochroma lagopus*	Stem Bark	Paula et al., (1998)
153	Bombaxoin	*Bombax anceps*	Root	Sichaem et al., (2010)
154	Caffeic acid	*Ceiba pentandra*	----	Bravo et al., (2002)
155	Neochlorogenic acid	*Bombax ceiba*	Flower	Wu et al., (2008)
156	*trans*-3-(*p*-Coumaroyl)-quinic acid	*Bombax ceiba*	Flower	Wu et al., (2008)
157	3-Methyl-2(3*H*)-benzofuranone	*Bombax ceiba*	Flower	Wu et al., (2008)
O) Lactones:				
158	Argentilactone I	*Chorisia crispiflora*	----	Matsuda et al., (1994)
159	Argentilactone II	*Chorisia crispiflora*	----	Matsuda et al., (1994)
160	(*R*)-6-[(*Z*)-1-Heptenyl)]-5,6-dihydro-2*H*-pyran-2-one	*Chorisia crispiflora*	----	Matsuda et al., (1994)
161	Bombalin	*Bombax ceiba*	Flower	Wu et al., (2008)
162:165	Lactones I–IV	*Quararibea funebris*	Flower	Raffauf et al., (1984)
P) Fatty acids:				
166	Caproic acid (hexanoic acid) $C_{6:0}$	*Bombax costatum*	----	Ogbobe et al., (1996)
167	Caprylic acid (Octanoic acid) $C_{8:0}$	*Bombax costatum*	----	Ogbobe et al., (1996)
168	Myristic acid (Tetradecanoic acid) $C_{14:0}$	*Adansonia digitata*	Root, Seed	Gaydou et al., (1981); Ralaimanarivo et al., (1982); Ramesh et al., (1992)
		A. fony	Seed	
		A. grandidieri	Seed	
		A. madagascariensis	Seed	
		A. suarezensis	Seed	
		A. za	Seed	
		Bombax ceiba	Seed Flower	Versiani, (2004)
		Chorisia insignis	Seed	Hassan, (2009)
169	Pentadecanoic acid $C_{15:0}$	*Adansonia digitata*	Root, Seed	Gaydou et al., (1981); Ralaimanarivo et al., (1982); Ramesh et al., (1992)
		A. fony	Seed	
		A. grandidieri	Seed	
		A. madagascariensis	Seed	
		A. suarezensis	Seed	
		A. za	Seed	
170	Palmitic acid (hexadecanoic acid) $C_{16:0}$	*Adansonia digitata*	Root	Gaydou et al., (1981); Ralaimanarivo et al., (1982); Ramesh et al., (1992)
		A. fony	Seed	
		A. grandidieri	Seed	
		A. madagascariensis	Seed	
		A. suarezensis	Seed	
		A. za	Seed	
		Bombax aquaticum	Seed	Schuch et al., (1986)
		Bombax ceiba	Seed,	Dhar & Munjal, (1976); Versiani, (2004)
			Flower	Versiani, (2004)
		Bombax costatum	----	Ogbobe et al., (1996)
		Bombax sessile	----	Bravo et al., (2002)
		Ceiba pentandra	----	Bravo et al., (2002)

(Continued)

Table 1. *(Continued)*.

No.	Compound	Plant Source	Part	Ref.
		Chorisia insignis	Seed	Hassan, (2009)
		Chorisia speciosa	Seed	Bohannon & Kleiman, (1978)
		Ochroma lagopus	Heart Wood	Paula et al., (1996)
		Pachira aquatica	Seed	Rizk & Al-Nowaihi, (1989)
171	Palmitoleic acid $C_{16:1}$	*Adansonia digitata*	Root	Gaydou et al., (1981); Ralaimanarivo et al., (1982); Ramesh et al., (1992)
		A. fony	Seed	
		A. grandidieri	Seed	
		A. madagascariensis	Seed	
		A. suarezensis	Seed	
		A. za	Seed	
		Bombax ceiba	Seed	Versiani, (2004)
		Chorisia speciosa	Seed	Bohannon & Kleiman, (1978)
172	Heptadecanoic acid $C_{17:0}$	*Adansonia digitata*	Root, Seed	Gaydou et al., (1981); Ralaimanarivo et al., (1982); Ramesh et al., (1992)
		A. fony	Seed	
		A. grandidieri	Seed	
		A. madagascariensis	Seed	
		A. suarezensis	Seed	
		A. za	Seed	
		Bombax ceiba	Seed	Bohannon & Kleiman, (1978)
		Chorisia speciosa	Seed	
		Pachira aquatica	Seed	
173	Heptadecenoic acid $C_{17:1}$	*Adansonia digitata*	Root, Seed	Gaydou et al., (1981); Ralaimanarivo et al., (1982); Ramesh et al., (1992)
		A. fony	Seed	
		A. grandidieri	Seed	
		A. madagascariensis	Seed	
		A. suarezensis	Seed	
		A. za	Seed	
		Bombax ceiba	Seed	Bohannon & Kleiman, (1978)
		Chorisia speciosa	Seed	Bohannon & Kleiman, (1978)
174	Heptadecadienoic acid $C_{17:2}$	*Adansonia digitata*	Root, Seed	Gaydou et al., (1981); Ralaimanarivo et al., (1982); Ramesh et al., (1992)
		A. fony	Seed	
		A. grandidieri	Seed	
		A. madagascariensis	Seed	
		A. suarezensis	Seed	
		A. za	Seed	
175	Stearic acid $C_{18:0}$	*Adansonia digitata*	Root, Seed	Gaydou et al., (1981); Ralaimanarivo et al., (1982); Ramesh et al., (1992)
		A. fony	Seed	
		A. grandidieri	Seed	
		A. madagascariensis	Seed	

(Continued)

Table 1. *(Continued)*.

No.	Compound	Plant Source	Part	Ref.
		A. suarezensis	Seed	
		A. za	Seed	
		Bombax aquaticum	Seed	Schuch et al., (1986)
		Bombax ceiba	Seed	Versiani, (2004)
		Bombax costatum	----	Ogbobe et al., (1996)
		Chorisia insignis	Seed	Hassan, (2009)
		Chorisia speciosa	Seed	Bohannon & Kleiman, (1978)
		Ochroma lagopus	Heart Wood	Paula et al., (1996)
		Pachira aquatica	Seed	Bohannon & Kleiman, (1978)
176	Octadec-7-enoic acid $C_{18:1}$ ω7	*Adansonia digitata*	Root, Seed	Gaydou et al., (1981); Ralaimanarivo et al., (1982); Ramesh et al., (1992)
		A. fony	Seed	
		A. grandidieri	Seed	
		A. madagascariensis	Seed	
		A. suarezensis	Seed	
		A. za	Seed	
177	Oleic acid $C_{18:1}$ ω9	*Adansonia digitata*	Root, Seed	
		A. fony	Seed	Gaydou et al., (1981); Ralaimanarivo et al., (1982); Ramesh et al., (1992)
		A. grandidieri	Seed	
		A. madagascariensis	Seed	
		A. suarezensis	Seed	
		A. za	Seed	
		Bombax aquaticum	Seed	Schuch et al., (1986)
		Bombax ceiba	Seed	Versiani, (2004)
		Bombax costatum	----	Ogbobe et al.,(1996)
		Bombax sessile	----	Bravo et al., (2002)
		Ceiba pentandra	----	Bravo et al., (2002)
		Chorisia insignis	Seed	Hassan, (2009)
		Chorisia speciosa	Seed	Bohannon & Kleiman, (1978)
		Ochroma lagopus	Heart Wood Seed	Bohannon & Kleiman, (1978)
		Pachira aquatica		Paula et al., (1996)
178	Linoleic acid $C_{18:2}$ ω6	*Adansonia digitata*	Root, Seed	
		A. fony	Seed	Gaydou et al., (1981); Ralaimanarivo et al., (1982); Ramesh et al., (1992)
		A. grandidieri	Seed	
		A. madagascariensis	Seed	
		A. suarezensis	Seed	
		A. za	Seed	
		Bombax aquaticum	Seed	Schuch et al., (1986)
		Bombax ceiba	Seed	Versiani, (2004)
		Bombax costatum	----	Ogbobe et al., (1996)

(Continued)

Table 1. *(Continued)*.

No.	Compound	Plant Source	Part	Ref.
		Bombax sessile	----	Bravo et al., (2002)
		Ceiba pentandra	----	Bravo et al., (2002)
		Chorisia insignis	Seed	Hassan, (2009)
		Chorisia speciosa	Seed	Bohannon & Kleiman, (1978)
		Ochroma lagopus	Heart Wood	Paula et al., (1996)
			Seed	
		Pachira aquatica		Bohannon & Kleiman, (1978)
179	Linolenic acid $C_{18:3}$ ω3	*Adansonia digitata*	Root,	Gaydou et al., (1981);
			Seed	Ralaimanarivo et al.,
		A. fony	Seed	(1982); Ramesh et al.,
		A. grandidieri	Seed	(1992)
		A. madagascariensis	Seed	
		A. suarezensis	Seed	
		A. za	Seed	
		Ochroma lagopus	Heart Wood	Paula et al., (1996)
180	Arachidic acid $C_{20:0}$	*Adansonia digitata*	Root,	Gaydou et al., (1981);
			Seed	Ralaimanarivo et al.,
		A. fony	Seed	(1982); Ramesh et al.,
		A. grandidieri	Seed	(1992)
		A. madagascariensis	Seed	
		A. suarezensis	Seed	
		A. za	Seed	
		Bombax costatum	----	Ogbobe et al.,(1996)
		Chorisia insignis	Seed	Hassan, (2009)
		Chorisia speciosa	Seed	Bohannon & Kleiman, (1978)
		Pachira aquatica	Seed	Bohannon & Kleiman, (1978)
181	Eicosenoic acid $C_{20:1}$	*Adansonia digitata*	Root,	Gaydou et al., (1981);
			Seed	Ralaimanarivo et al.,
		A. fony	Seed	(1982); Ramesh et al.,
		A. grandidieri	Seed	(1992)
		A. madagascariensis	Seed	
		A. suarezensis	Seed	
		A. za	Seed	
		Chorisia speciosa	Seed	Bohannon & Kleiman, (1978)
182	Behenic acid $C_{22:0}$	*Adansonia digitata*	Root,	Gaydou et al., (1981);
			Seed	Ralaimanarivo et al.,
		A. fony	Seed	(1982); Ramesh et al.,
		A. grandidieri	Seed	(1992)
		A. madagascariensis	Seed	

(Continued)

Table 1. *(Continued)*.

No.	Compound	Plant Source	Part	Ref.
		A. suarezensis	Seed	
		A. za	Seed	
		Bombax ceiba	Seed	Versiani, (2004)
		Chorisia insignis	Seed	Hassan, (2009)
183	Lignoceric acid (tetracosanoic acid) $C_{24:0}$	*Bombax costatum*	----	Ogbobe et al., (1996)
184	Vernolic acid	*Bombax ceiba*	Seed	Bohannon & Kleiman, (1978)
	(Linoleic acid 12:13-oxide)	*Bombax costatum*	----	Ogbobe et al., (1996)
		Chorisia speciosa	Seed	Bohannon & Kleiman, (1978)
185	C_{20} Monoethylenic acid	*Chorisia insignis*	Seed	Hassan, (2009)
186	Malvalic acid (8,9-methylene -heptadec-8-enoic)	*Adansonia digitata*	Root, Seed	Gaydou et al., (1981); Ralaimanarivo et al., (1982); Ramesh et al., (1992)
		A. fony	Seed	
		A. grandidieri	Seed	
		A. madagascariensis	Seed	
		A. suarezensis	Seed	
		A. za	Seed	
		Bombax oleagineum	----	Bravo et al., (2002)
		Ceiba acuminata	Seed	Bravo et al., (2002)
		Ceiba pentandra	----	Bravo et al., (2002)
		Chorisia insignis	Seed	Hassan, (2009)
		Chorisia speciosa	Seed	Petronici et al., (1974); Hassan, (2009)
187	Dihydromalvalic acid	*Ceiba pentandra*	Seed	Kaimal & Gollamudi, (1972)
188	Sterculic acid (9,10-methylene-octadec-9-enoic)	*Adansonia digitata*	Root, Seed	Gaydou et al., (1981); Ralaimanarivo et al., (1982); Ramesh et al., (1992)
		A. fony	Seed	
		A. grandidieri	Seed	
		A. madagascariensis	Seed	
		A. suarezensis	Seed	
		A. za	Seed	
		Bombax oleagineum	----	Bravo et al., (2002)
		Ceiba acuminata	Seed	Bravo et al., (2002)
		Ceiba pentandra	----	Bravo et al., (2002)
		Chorisia insignis	Seed	Hassan, (2009)
		Chorisia speciosa	Seed	Petronici et al., (1974); Hassan, (2009)`
		Pachira aquatica	Seed	Gibbs, (1974)
189	Dihydrosterculic acid	*Adansonia digitata*	Root, Seed	Gaydou et al., (1981); Ralaimanarivo et al., (1982); Ramesh et al., (1992)
		A. fony	Seed	
		A. grandidieri	Seed	

(Continued)

Table 1. *(Continued)*.

No.	Compound	Plant Source	Part	Ref.
		A. madagascariensis	Seed	
		A. suarezensis	Seed	
		A. za	Seed	
190	2-Hydroxy-sterculic acid	*Bombacopsis glabra*	Seed	Gibbs, (1974)
		Pachira insignis	Seed	Gibbs, (1974)
191	Fatty acids	*Cavanillesia hylogeiton*	Stem Bark	Bravo et al., (2002)
Q) Fatty esters and triacylglycerols:				
192	Octyl palmitate	*Bombax ceiba*	Seed	Dhar & Munjal,(1976)
193	Octadecyl palmitate	*Bombax ceiba*	Seed	Dhar & Munjal,(1976)
194	1,3-Dipalmitoyl-2-oleoyl-glycerol	*Bombax munguba*	Seed	Schuch et al., (1986)
195	1,3-Dipalmitoyl-2- linoleoyl-glycerol	*Bombax munguba*	Seed	Schuch et al., (1986)
196	1,3-Dipalmitoyl-2-sterculoylglycerol	*Bombax munguba*	Seed	Schuch et al., (1986)
197	Triglycerides with linoleic acid	*Chorisia speciosa*	Seed	Petronici et al., (1974)
198	Glycerol derivatives	*Cavanillesia hylogeiton*	Stem Bark	Bravo et al., (2002)
R) Amino acids:				
199	Alanine	*Bombax ceiba*	Flower	Versiani, (2004)
		Ochroma lagopus	Nectar, Pollen	Paula, (1995); Paula et al., (1997)
200	Arginine	*Adansonia digitata*	Leaf	Yazzie et al., (1994)
		Bombax ceiba	Flower	Versiani, (2004)
		Bombax pentandrum	----	Versiani, (2004)
		Ochroma lagopus	Pollen	Paula, (1995); Paula et al., (1997)
201	Asparagine	*Ochroma lagopus*	Nectar	Paula, (1995); Paula et al., (1997)
202	Aspartic acid	*Ochroma lagopus*	Nectar	Paula, (1995); Paula et al., (1997)
203	Cysteine	*Adansonia digitata*	Leaf	Yazzie et al., (1994).
		Ochroma lagopus	Nectar, Pollen	Paula, (1995); Paula et al., (1997)
204	Glutamine	*Ochroma lagopus*	Nectar	Paula, (1995); Paula et al., (1997)
205	Glutamic acid	*Bombax ceiba*	Flower	Versiani, (2004)
		Ochroma lagopus	Nectar	Paula, (1995); Paula et al., (1997)
206	Glycine	*Ochroma lagopus*	Nectar, Pollen	Paula, (1995); Paula et al., (1997)
207	Glycocol	*Bombax ceiba*	Flower	Versiani, (2004)
208	Histidine	*Bombax pentandrum*	----	Versiani, (2004)
		Ochroma lagopus	Nectar, Pollen	Paula, (1995); Paula et al., (1997)
209	Isoleucine	*Adansonia digitata*	Leaf	Yazzie et al., (1994)
		Bombax pentandrum	----	Versiani, (2004)
		Ochroma lagopus	Nectar	Paula, (1995); Paula et al., (1997)
210	(2*S*,3*S*,4*R*)-γ-Hydroxy-isoleucine	*Quararibea funebris*	Flower	Raffauf et al., (1984)
211	Leucine	*Adansonia digitata*	Leaf	Yazzie et al., (1994)
		Bombax pentandrum	----	Versiani, (2004)
212	Lysine	*Adansonia digitata*	Leaf	Yazzie et al., (1994)
		Bombax ceiba	Flower	Versiani, (2004)
		Ochroma lagopus	Nectar, Pollen	Paula, (1995); Paula et al., (1997)

(Continued)

Table 1. *(Continued)*.

No.	Compound	Plant Source	Part	Ref.
213	Methionine	*Adansonia digitata*	Leaf	Yazzie et al., (1994).
		Bombax pentandrum	----	Versiani, (2004)
		Ochroma lagopus	Nectar, Pollen	Paula, (1995); Paula et al., (1997)
214	Phenyl alanine	*Adansonia digitata*	Leaf	Yazzie et al., (1994).
		Bombax pentandrum	----	Versiani, (2004)
		Ochroma lagopus	Nectar	Paula, (1995); Paula et al., (1997)
215	Proline	*Ochroma lagopus*	Pollen	Paula, (1995); Paula et al., (1997)
216	Serine	*Ochroma lagopus*	Nectar, Pollen	Paula, (1995); Paula et al., (1997)
217	Threonine	*Adansonia digitata*	Leaf	Yazzie et al., (1994).
		Bombax pentandrum	----	Versiani, (2004)
		Ochroma lagopus	Nectar	Paula, (1995); Paula et al., (1997)
218	Tryptophan	*Adansonia digitata*	Leaf	Yazzie et al., (1994).
		Bombax pentandrum	----	Versiani, (2004)
219	Tyrosine	*Adansonia digitata*	Leaf	Yazzie et al., (1994)
		Ochroma lagopus	Pollen	Paula, (1995); Paula et al., (1997)
220	Valine	*Adansonia digitata*	Leaf	Yazzie et al., (1994).
		Bombax pentandrum	----	Versiani, (2004)
		Ochroma lagopus	Nectar	Paula, (1995); Paula et al., (1997)
S) Carbohydrates:				
1) Monosaccharides:				
221	Arabinose	*Bombax ceiba*	Flower	Versiani, (2004)
		Chorisia speciosa	Fruit	Beleski-Carneiro et al., (1999)
			Gum	Di Fabio & Dutton, (1982)
222	Fructose	*Ochroma lagopus*	Nectar	Paula, (1995); Paula et al., (1997)
223	Galactose	*Bombax ceiba*	Flower	Versiani, (2004)
		Chorisia speciosa	Fruit	Beleski-Carneiro et al., (1999)
			Gum	Di Fabio & Dutton, (1982)
			Seed	Beleski-Carneiro et al., (2002)
224	Glucose	*Bombax ceiba*	Flower	Versiani, (2004)
		Chorisia speciosa	Fruit	Beleski-Carneiro et al., (1999)
		Ochroma lagopus	Nectar	Paula, (1995); Paula et al., (1997)
225	Mannose	*Chorisia speciosa*	Fruit	Beleski-Carneiro et al., (1999)
			Gum	Di Fabio & Dutton, (1982)
226	Rhamnose	*Chorisia speciosa*	Fruit	Beleski-Carneiro et al., (1999)
			Gum	Di Fabio & Dutton, (1982)
			Seed	Beleski-Carneiro et al., (2002)
227	Xylose	*Chorisia speciosa*	Fruit	Beleski-Carneiro et al., (1999)
			Gum	Di Fabio and Dutton, (1982)

(Continued)

Table 1. *(Continued)*.

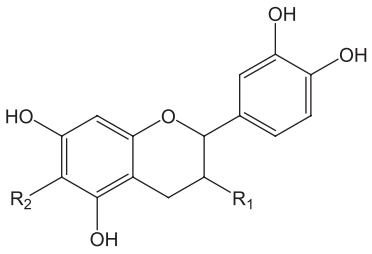
No.	Compound	Plant Source	Part	Ref.
2) Disaccharides:				
228	Lactose	*Bombax ceiba*	Flower	Versiani, (2004)
229	Sucrose	*Bombax ceiba*	Flower	Versiani, (2004)
		Ochroma lagopus	Nectar	Paula, (1995); Paula et al., (1997)
3) Polysaccharides:				
a) Homopolysaccharides:				
230	Cellulose	*Bombax ceiba*	Seed	Versiani, (2004)
231	Pentosan	*Bombax ceiba*	Seed	Versiani, (2004)
232	Starch-type glucan	*Bombax ceiba*	Root	Haq & Gomes, (1973)
b) Heteropolysaccharides:				
233	Polysaccharide consists of: D-galactose and L-arabinose	*Bombax ceiba*	Seed	Das et al., (1990)
234	Polysaccharide consists of: D-galactose, L-arabinose and L-rhamnose	*Bombax ceiba*	Flower	Agrawal et al., (1972)
235	Polysaccharide consists of: rhamnose, arabinose, galactose and uronic acid	*Chorisia speciosa*	Floss Silk	Beleski-Carneiro et al., (1996)
236	Polysaccharide contains: fucose, xylose, arabinose, glucose, galactose, glucuronic acid, and 4-*O*-methyl-D-glucuronic acid	*Ceiba pentandra*	Stem Bark	Raju et al., (1989)
4) Derived carbohydrates and uronic acids:				
237	Glucuronic acid	*Chorisia speciosa*	Fruit	Beleski-Carneiro et al.,(1999)
			Seed	Beleski-Carneiro et al.,(2002)
			Gum	Di Fabio & Dutton, (1982)
238	6-*O*-(β-D-Galactopyranosyl-uronic acid)-D-galactose	*Bombax ceiba*	Gum	Bose & Dutta, (1963)
239	Mucilage contains: galactose, rhamnose, xylose, mannose, arabinose and glucuronic acid	*Chorisia speciosa***	Flower	Hafez et al., (2003)
240	Mucilage contains: glucuronic acid, galacturonic acid, rhamnose, galactose, glucose, arabinose, xylose, mannose, ribose.	*Chorisia speciosa***	Leaf	Caffini & Lufrano, (1978)
T) Vitamins, inorganic salts and minerals:				
241	Vitamin A	*Adansonia digitata*	Leaf	De Caluwé et al., (2010)
242	Vitamin C	*Adansonia digitata*	Fruit	De Caluwé et al., (2010)
243	Vitamin B1	*Adansonia digitata*	Fruit	Lockett et al., (2000)
244	Vitamin B2	*Adansonia digitata*	Fruit	Lockett et al., (2000)
245	Vitamin B6	*Adansonia digitata*	Fruit	Lockett et al., (2000)
246	Potassium nitrate	*Bombax ceiba*	Root	Qi et al., (1996)
247	Minerals: Ca, Mg, K, Fe, Mn, Mo, P and Zn.	*Adansonia digitata*	Leaf	Yazzie et al., (1994);
			Fruit	De Caluwé et al., (2010)

*Absent in *A. za* and *A. fony*.

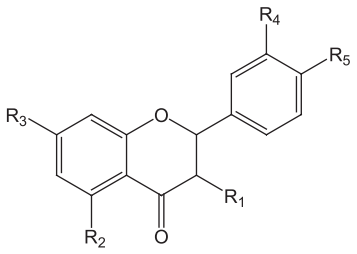
**Mucilage of *C. speciosa* leaves contains ribose and mannose; Mucilage of *C. crispiflora* and *C. pubiflora* leaves contains ribose but no mannose; Mucilage of *C. insignis* leaves contains no mannose or ribose (Lufrano & Caffini, 1981).

(0.25%), *cis*-geranyl-acetone (0.25%), β-cydrane (0.2%), β-jonylcrotonate (0.2%), precyclemone B (0.19%), 2-ethyl-hex-propionate (0.14%), α-muurolen (0.12%)] (Macfarlane et al., 2003).

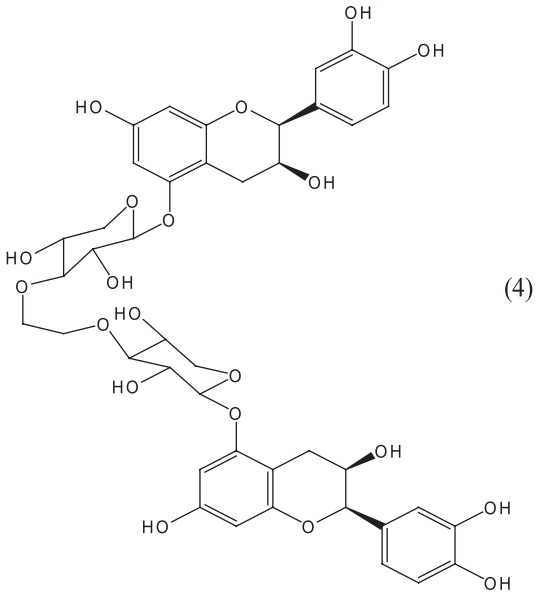
In another study, the volatile oil of *Pachira dolichocalyx* A. Robyns bark and leaves were found to contain (*Z*)-2-hexenol, octanone, hexenyl butanoate, allo-ocimene, *trans*-linalool-oxide, mentha-1-7(8)-diene, *p*-cymenene,



	R_1	R_2
(1)	βOH	H
(2)	αOH	H
(3)	O-Xyl.(4→1)Glc.	OMe

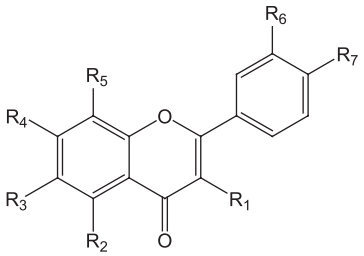


	R_1	R_2	R_3	R_4	R_5
(5)	H	OH	O-Glc.(6→1)Rha.	OH	OMe
(6)	OH	H	O-Rha.	OH	OH
(7)	OH	O-Glc.(4→1)Gal.	OH	H	H

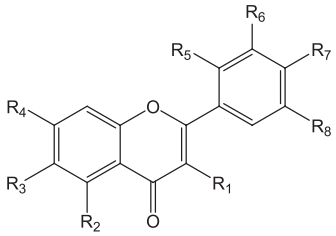


(4)

Figure 1. Compounds isolated from the family Bombacaceae.

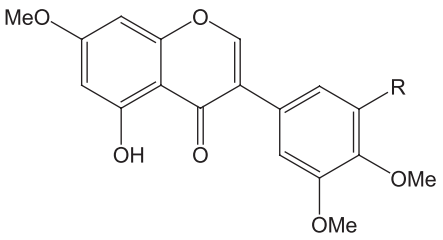


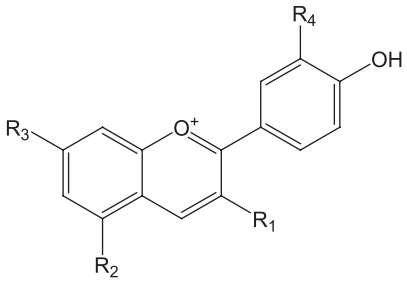
	R_1	R_2	R_3	R_4	R_5	R_6	R_7
(8)	H	OH	H	OH	H	H	OH
(9)	H	OH	H	O-Glc.(6→1)Rha.	H	H	OH
(10)	H	OH	H	OH	β*C*-Glc.	H	OH
(11)	H	OH	H	βO-Glc.	H	H	OH
(12)	H	OH	H	OMe	H	H	OMe
(13)	OMe	OH	H	OMe	H	H	OMe
(14)	OMe	OH	OMe	OMe	H	H	OMe
(15)	OMe	OH	OMe	OMe	OMe	H	OMe
(16)	H	OH	β*C*-Glc.	OH	H	H	OH
(17)	H	OH	H	O-Glc.(6→1)Rha.	H	H	OMe
(18)	H	OH	H	OH	H	OH	OH
(19)	H	OH	H	βO-Glc.	H	OH	OH
(20)	H	OMe	H	OMe	H	H	H
(21)	OMe	OMe	H	OMe	H	H	H
(22)	H	OH	H	O-Glc.(2→1)Rha.	H	OH	OH
(23)	H	OH	H	O-Glc.(6→1)Rha.	H	OH	OH
(24)	H	OH	H	O-Glc.(2→1)Rha.	H	H	OH
(25)	H	OH	β*C*-Glc.	βO-Glc.	H	H	OH
(26)	H	OH	H	OH	H	OMe	OH
(27)	H	OH	β*C*-Glc.	OH	β*C*-Glc.	H	OH
(28)	H	OH	OMe	OMe	OMe	H	OH



	R_1	R_2	R_3	R_4	R_5	R_6	R_7	R_8
(32)	OH	OH	H	O-Glc.(6→1)Rha.	H	H	OMe	H
(33)	OH	OH	H	OH	H	H	OH	H
(34)	OH	OH	H	OH	H	OH	OH	H
(35)	βO-Glc.	OH	H	OH	H	OH	OH	H
(36)	OH	OH	H	βO-Xyl.	H	H	OH	H
(37)	O-Glc.(6→1)Rha.	OH	H	OH	H	OH	OH	H
(38)	OH	OH	β*C*-Glc.	OH	OH	H	OH	OH
(39)	β O-(6″-*p*-coumaroyl)-Glc.	OH	H	OH	H	H	OH	H
(40)	O-Rha.(4→1)Glc.	OH	H	OH	H	H	OH	H
(41)	βO-Glc.	H	OMe	H	H	OH	OH	OH

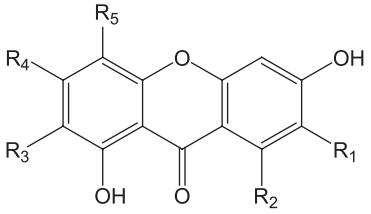
Figure 1. *(Continued).*



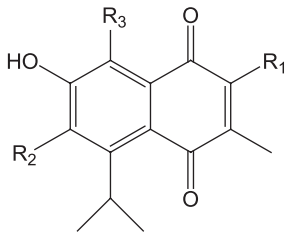


	R_1	R_2	R_3	R_4
(42)	βO-Glc.	OH	OH	OH
(43)	βO-Glc.	βO-Glc.	OH	OH
(44)	βO-Glc.	OH	OMe	OH
(45)	O-Glc.(6→1)Rha.	OH	OH	H
(46)	OH	βO-Glc.	OH	H
(47)	βO-Glc.	βO-Glc.	OH	H

	R
(29)	O-Glc.(6→1)Ara.(f)
(30)	OH
(31)	βO-Glc.

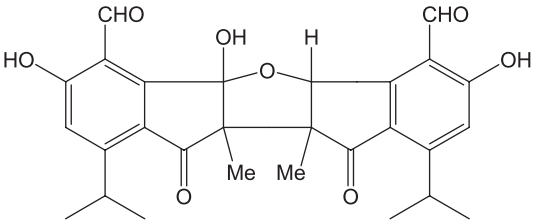


	R_1	R_2	R_3	R_4	R_5
(48)	OH	H	β*C*-Glc.	O-*p*-hydroxybenzoyl	H
(49)	O-*p*-hydroxybenzoyl	OH	H	O-*p*-hydroxybenzoyl	β*C*-Glc.
(50)	OH	H	β*C*-Glc.	OH	H
(51)	OH	O-*p*-hydroxybenzoyl	H	OH	β*C*-Glc.



	R_1	R_2	R_3
(52)	OMe	H	CHO
(53)	OH	H	CHO
(54)	OMe	H	CHO
(55)	OMe	H	H
(56)	H	OH	CHO
(57)	H	OMe	CHO
(62)	OMe	H	COOH

Figure 1. *(Continued).*



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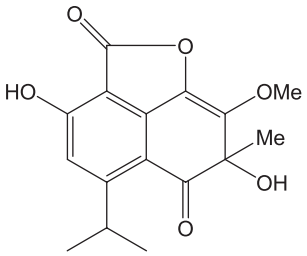

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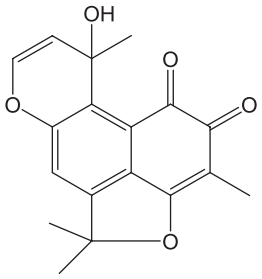

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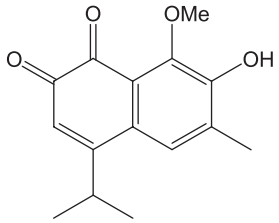

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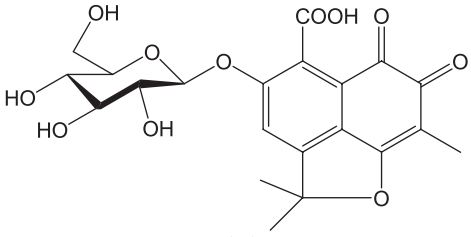

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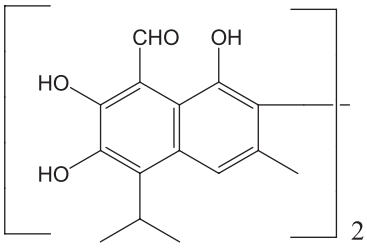

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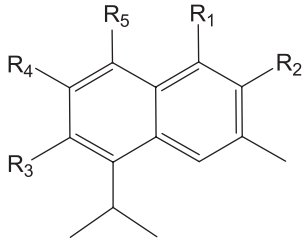
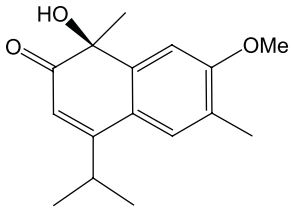
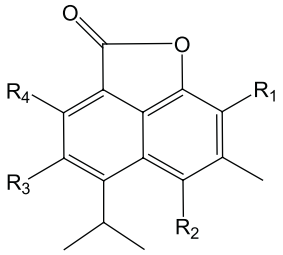


	R_1	R_2	R_3	R_4	R_5
(65)	OH	H	OH	OH	CHO
(66)	OH	H	OMe	OH	CHO
(67)	OMe	H	OMe	OMe	CHO
(68)	H	OH	H	H	Me
(69)	OH	OH	H	OH	CHO
(70)	OMe	OH	H	OH	CHO
(71)	OH	OMe	H	OH	CHO
(72)	OMe	OMe	H	OH	CHO
(73)	OH	OMe	H	OMe	CHO

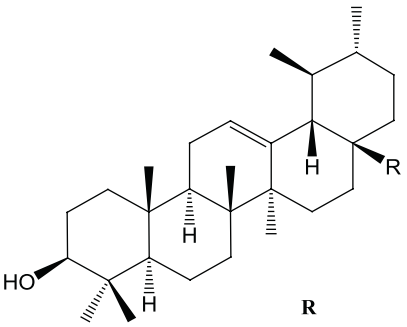
Figure 1. *(Continued).*

(74)

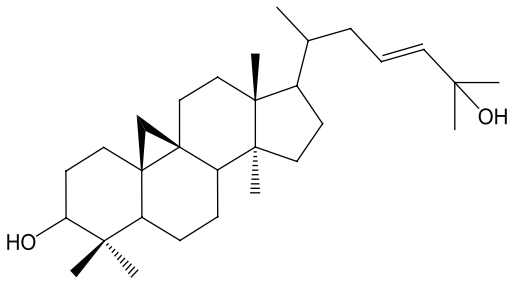




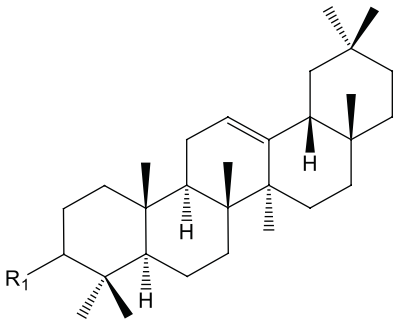
	R_1	R_2	R_3	R_4
(75)	OH	H	H	OMe
(76)	H	H	OH	OMe
(77)	OH	H	H	OH
(78)	OMe	H	H	OMe
(79)	OMe	OMe	H	OMe



	R
(80)	Me
(91)	COOH

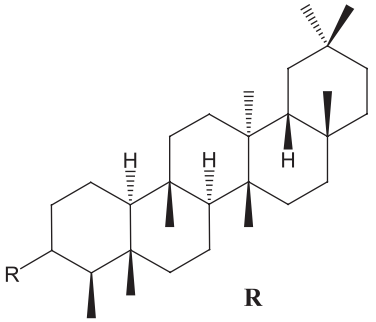


(83)



	R_1
(81)	βO-palmitoyl
(82)	= O

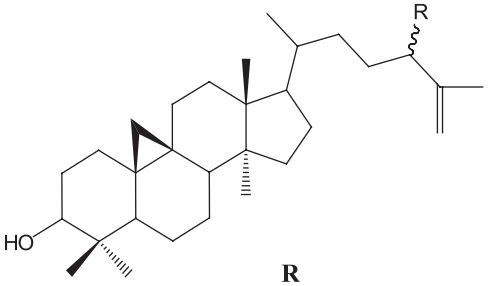
Figure 1. *(Continued).*



R

(86) = O

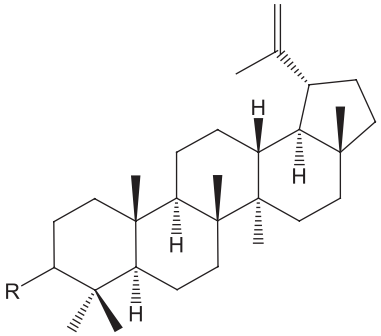
(87) β-OH



R

(84) β-OH

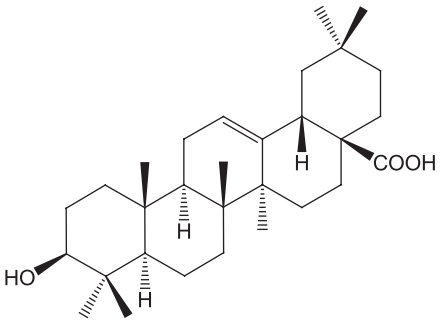
(85) α-OH



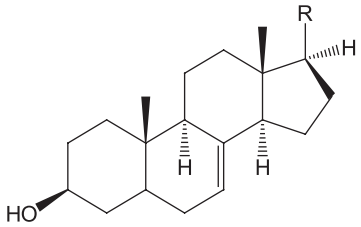
R

(88) β-OH

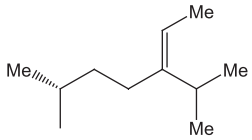
(89) = O



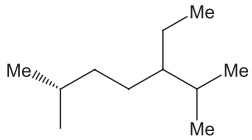
(90)



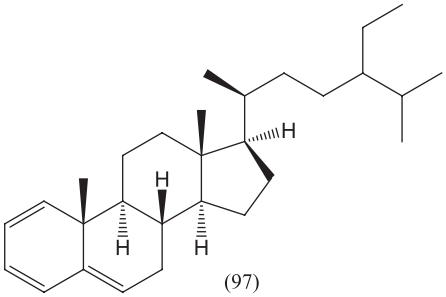
R



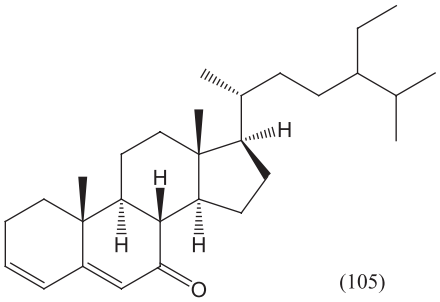
(92)



(104)

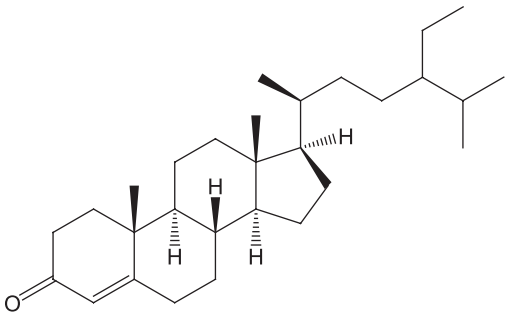


(97)

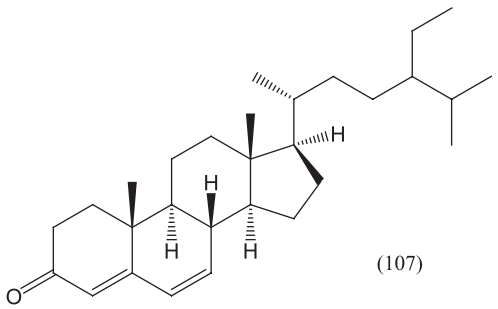


(105)

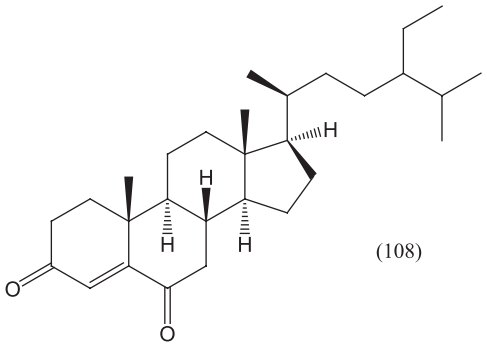
Figure 1. *(Continued).*



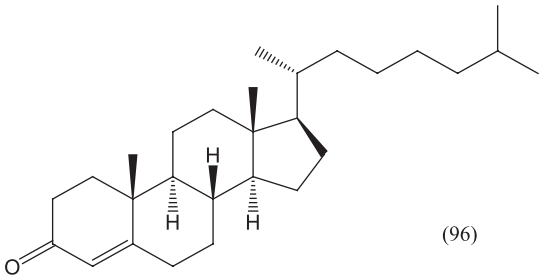
(106)



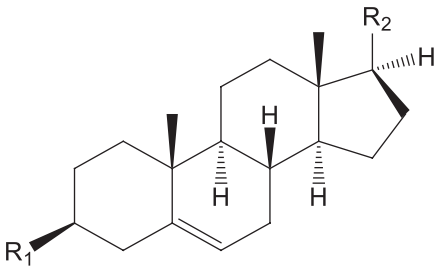
(107)



(108)



(96)



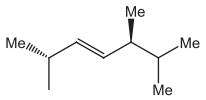
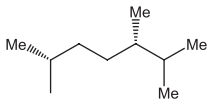
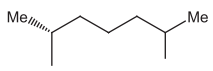
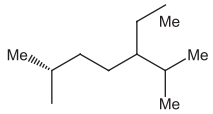
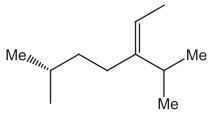
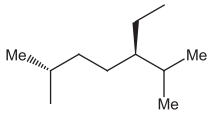
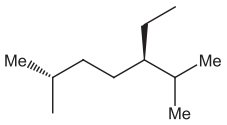
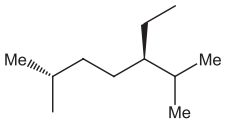
	R_1	R_2
(93)	OH	
(94)	OH	
(95)	OH	
(98)	O-Glc.(6→1)Ara.	
(99)	OH	
(100)	OH	

Figure 1. *(Continued).*

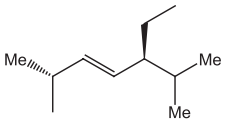
(101) = O

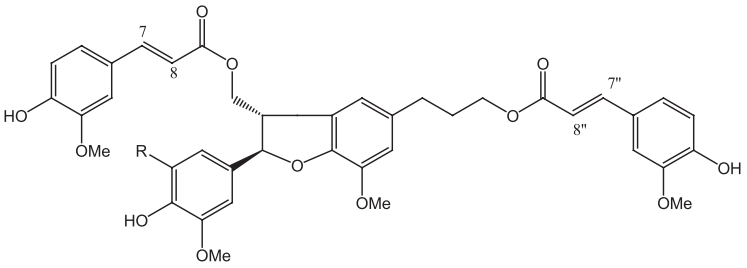


(102) βO-Glc.



(103) OH



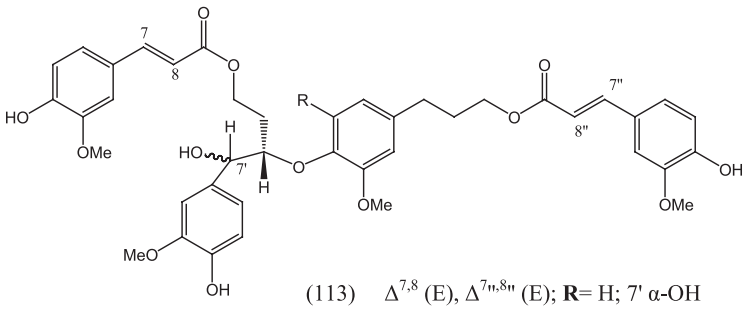


(109) $\Delta^{7,8}$ (E), $\Delta^{7'',8''}$ (E); **R**= H

(110) $\Delta^{7,8}$ (E), $\Delta^{7'',8''}$ (Z); **R**= H

(111) $\Delta^{7,8}$ (Z), $\Delta^{7'',8''}$ (E); **R**= H

(112) $\Delta^{7,8}$ (E), $\Delta^{7'',8''}$ (E); **R**= OMe



(113) $\Delta^{7,8}$ (E), $\Delta^{7'',8''}$ (E); **R**= H; 7' α-OH

(114) $\Delta^{7,8}$ (E), $\Delta^{7'',8''}$ (E); **R**= H; 7' β-OH

(115) $\Delta^{7,8}$ (E), $\Delta^{7'',8''}$ (Z); **R**= H; 7' β-OH

(116) $\Delta^{7,8}$ (Z), $\Delta^{7'',8''}$ (E); **R**= H; 7' β-OH

(117) $\Delta^{7,8}$ (E), $\Delta^{7'',8''}$ (E); **R**= OMe; 7' α-OH

(118) $\Delta^{7,8}$ (E), $\Delta^{7'',8''}$ (E); **R**= OMe; 7' β-OH

(119)

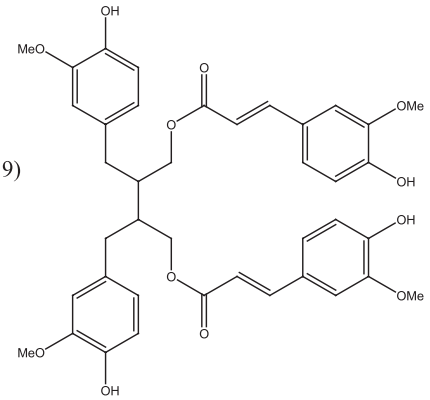
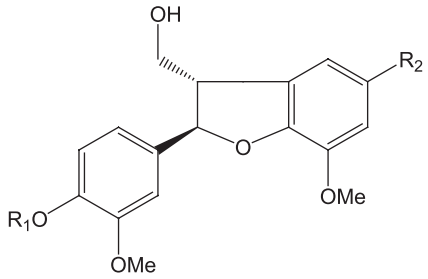
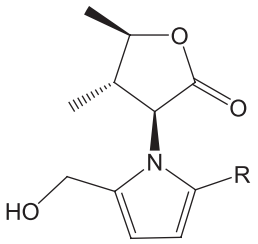


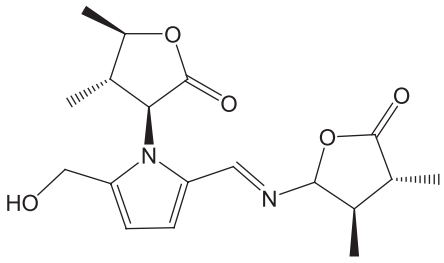
Figure 1. *(Continued)*.



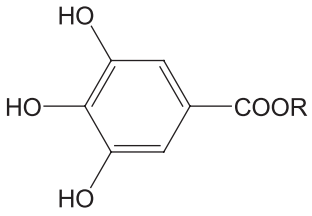
	R_1	R_2
(120)	H	–CO-Me
(121)	Glc.	–CO-Me
(122)	Glc.	$-(CH_2)_3$-OH



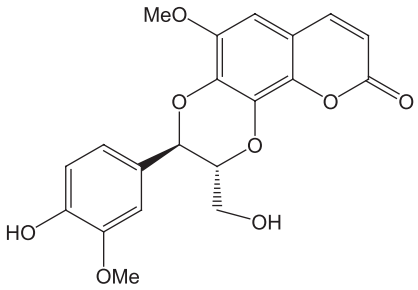
R	
(124)	-CHO
(125)	$-CH_2OH$



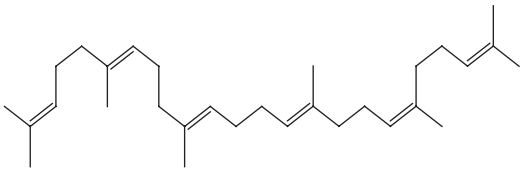
(126)



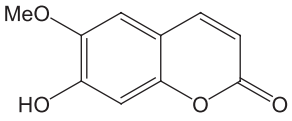
R	
(129)	H
(130)	$-C_2H_5$
(131)	Glc.



(127)

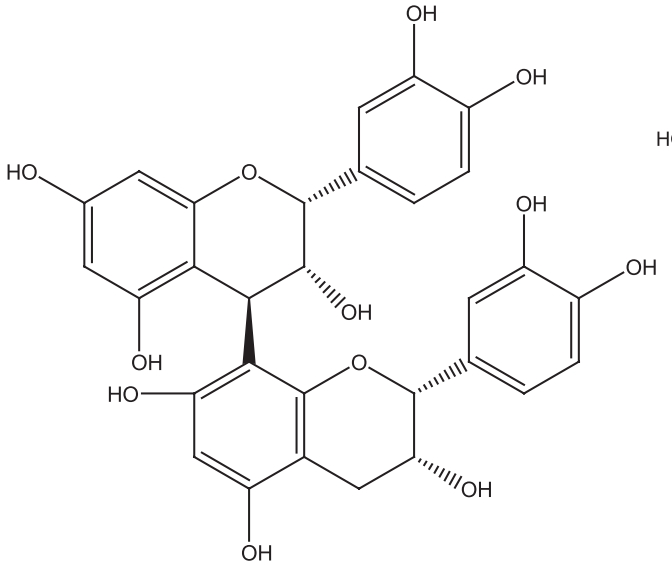


(140)

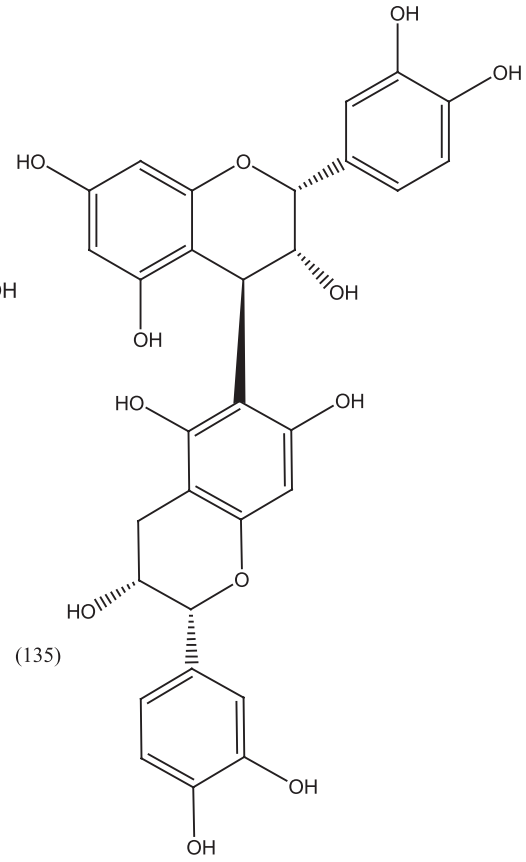


(128)

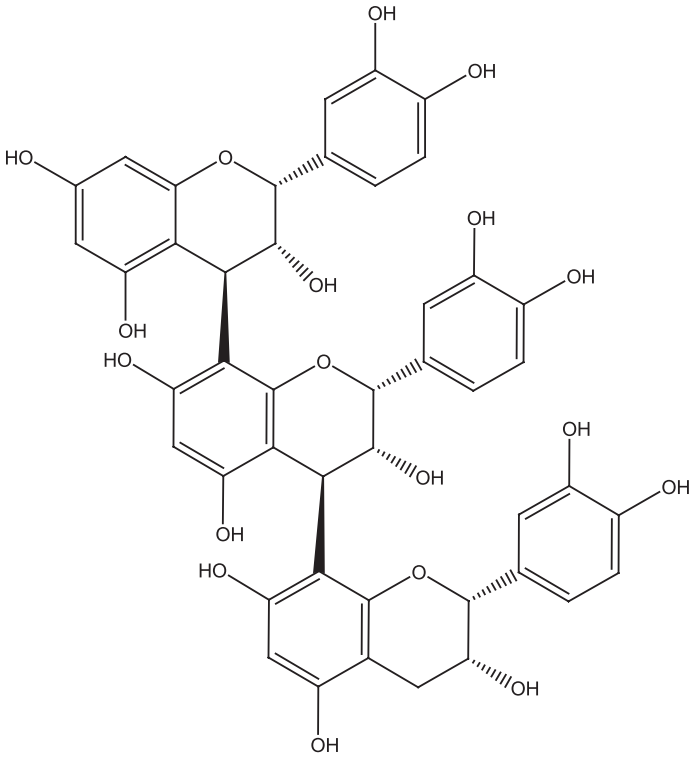
Figure 1. *(Continued).*



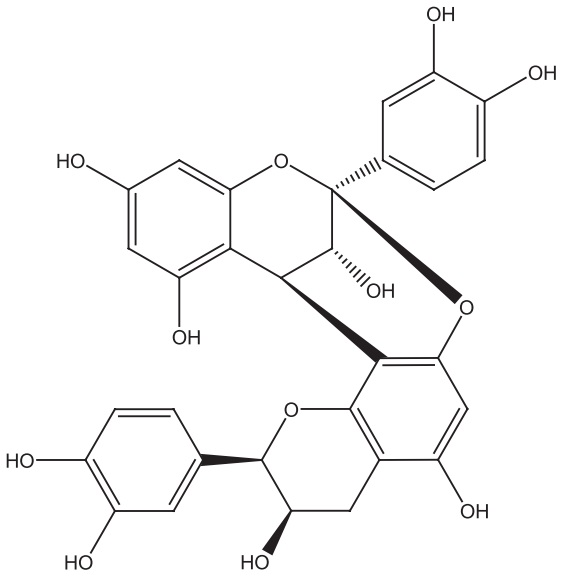
(134)



(135)

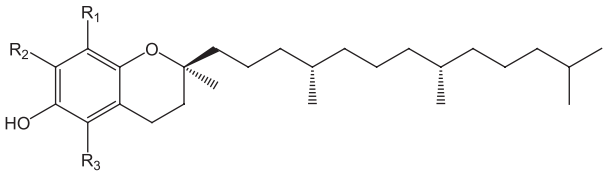


(137)

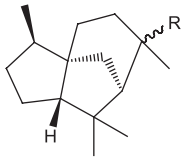


(136)

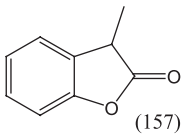
Figure 1. *(Continued).*



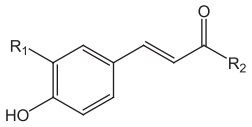
	R_1	R_2	R_3
(142)	Me	Me	Me
(143)	Me	H	Me
(144)	Me	Me	H
(145)	Me	H	H

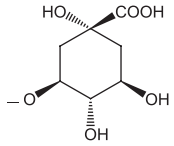
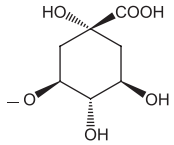
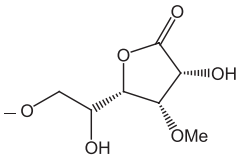


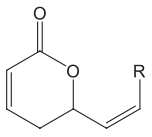
	R
(146)	α-OH
(147)	β-OH



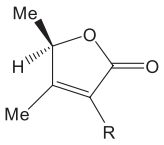
(157)



	R_1	R_2
(151)	H	O-$(CH_2)_{29}CH_3$
(154)	OH	OH
(155)	OH	
(156)	H	
(161)	H	



	R
(158)	–CH=CH–CO–C_2H_5
(159)	–CH=CH–CH(OH)–C_2H_5
(160)	–$(CH_2)_4$–CH_3



	R
(162)	OH
(163)	OMe
(164)	NH_2

Figure 1. *(Continued).*

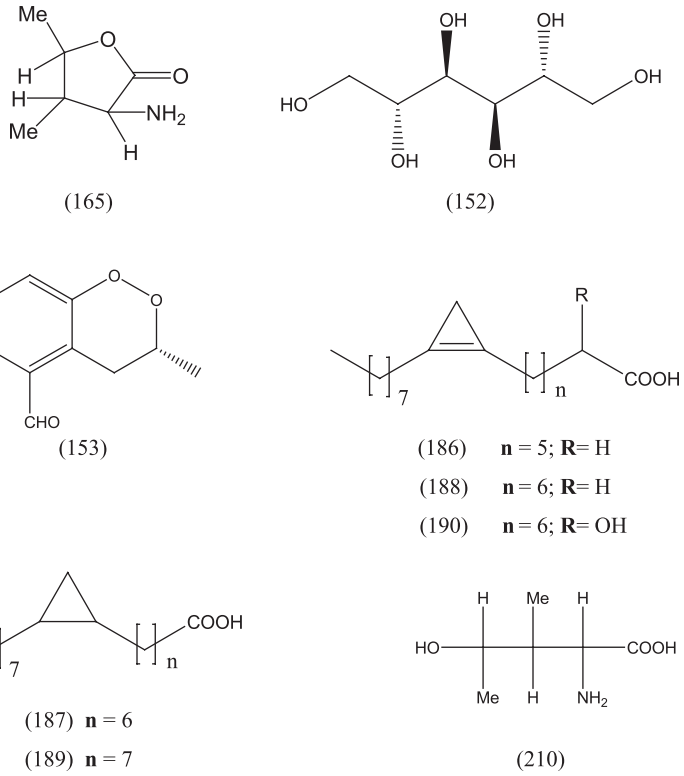


Figure 1. *(Continued).*

verbenene, cadina-1(10),6-diene and *epi*-α-muurolol (Courtois et al., 2009).

Conclusion

The overview of phytochemical studies on Bombacaceae has revealed a variety of chemical constituents produced by these plants. Flavonoids, anthocyanins, oxidized naphthalenes, sesquiterpenes, sesquiterpene lactones, triterpenes, steroids, lignans, alkaloids, amino acids, coumarins, long chain fatty acids as well as their esters, cyclopropenoid fatty acids and carbohydrates are the most significant isolated substances. Moreover, analysis of the volatile oils prepared from some Bombacaceae species demonstrated their richness in various compounds belonging to different structural types. As a result, the above reviewed findings doubtlessly present members of Bombacaceae as an untapped reservoir of chemical principles. This fact can also be substantiated by two evidences. Firstly, despite the large number of isolated compounds–especially after the great advance in isolation and spectral techniques–chemical investigations have focused predominantly on certain few species, with *Adansonia, Bombax, Ceiba, Chorisia, Ochroma* and *Pachira*, being relatively the most phytochemically visited genera leaving fertile fields for further phytochemical and pharmacological researches. Secondly, hybridization among different species is considered a common phenomenon among these plants. Both the unstudied species and new hybrids open the gate towards isolation of further new compounds. Furthermore, the chemical investigations of these untouched species will be of high chemotaxonomic value within this recently separated family.

Declaration of interest

The authors report no declarations of interest.

References

Agrawal GD, Rizvi SA, Gupta PC, Tewari JD. (1972). Study of a polysaccharide from the stamens of *Bombax malabaricum* flowers. *Planta Med*, 21, 293–303.

Al-Qarawi AA, Al-Damegh MA, El-Mougy SA. (2003). Hepatoprotective influence of *Adansonia digitata* pulp. *J Herbs Spices Med Plants*. 10, 1–6.

Beleski-Carneiro EB, Ganter JL, Reicher F. (1999). Structural aspects of the exudate from the fruit of *Chorisia speciosa* St. Hil. *Int J Biol Macromol*, 26, 219–224.

Beleski-Carneiro E, Sierakowski, MR, Ganter JL, Zawadzki-Baggio SF, Reichera F. (1996). Polysaccharides from *Chorisia speciosa* St. Hil. *Prog Biotechnol*, 14, 549–559.

Beleski-Carneiro E, Sugui J, Reicher F. (2002). Structural and biological features of a hydrogel from seed coats of *Chorisia speciosa*. *Phytochemistry*. 61, 157–163.

Bell AA, Stipanovic RD, O'Brien DH, Fryxell PA. (1978). Sesquiterpenoid aldehyde quinones and derivatives in pigment glands of *Gossypium*. *Phytochemistry*. 17, 1297–1305.

Benson L. (1970). *Plant Classification*. New Delhi, Bombay:Oxford and IBH publishing Co., 793–797.

Bianchini JP, Ralaimanarivo A, Gaydou EM, Waegell B. (1982). Hydrocarbons, sterols and tocopherols in the seeds of six *Adansonia* species. *Phytochemistry*. 21, 1981–1987.

Bohannon MB, Kleiman R. (1978). Cyclopropene fatty acids of selected seed oils from Bombacaceae, Malvaceae, and Sterculiaceae. *Lipids*, 13, 270–273.

Bose S, Dutta AS. (1963). Structure of *Salmalia malabarica* gum, Part-I: Nature of sugars present and the structure of aldobiuronic acids. *J Indian Chem Soc*. 40, 257–262.

Bravo JA, Lavaud C, Bourdy G, Giménez A, Sauvainc M. (2002). First bioguided phytochemical approach to *Cavanillesia Aff*. hylogeiton. *Rev Bol Quim*. 19, 18–24.

Caffini NO, Lufrano NS. (1978). Mucílagos de Malvales. I- Análisis fitoquímico del mucílago de hojas de *Chorisia speciosa* St.Hil. (Bombacaceae). Rev Farm. 120, 75–80.

Chauhan JS, Chaturvedi R, Kumar S. (1982). A new flavanol glycosoide from the stems of *Adansonia digitata*. *Indian J Chem B*. 21, 254–255.

Chauhan JS, Kumar S, Chaturvedi R. (1984). A new flavanonol glycoside from *Adansonia digitata* roots. *Planta Med*, 50, 113.

Chauhan JS, Kumar S, Cahturvedi R. (1987). A new flavanone glycoside from the roots of *Adansonia digitata*. *Nat Acad Sci Lett*. 10, 77–79.

Chauhan JS, Sultam M, Srivastava SK. (1980). Constituents from *Salmalia malabaricum*. *Can J Chem* 58, 328–330.

Courtois EA, Paine CE, Blandinieres PA, Stien D, Bessiere JM, Houel E, Baraloto C, Chave J. (2009). Diversity of the volatile organic compounds emitted by 55 species of tropical trees: A survey in French Guiana. *J Chem Ecol*, 35, 1349–1362.

Coussio JD. (1964). Isolation of rhoifolin from *Chorisia* species (Bombacaceae). *Experientia*, 20, 562.

Cronquist A. (1981). *An Integrated System of Classification of Flowering plants*. New York:Columbia University Press.

Das S, Ghosal PK, Ray B. (1990). Structural studies of a polysaccharide from the seeds of *Salmalia malabarica*. *Carbohydr Res*. 207, 336–340.

De Caluwé E, Halamova K, Van Damme P. (2010). *Adansonia digitata* L. A review of traditional uses, phytochemistry and pharmacology. *Afrika focus*. 23, 11–51.

Dhar DN, Munjal RC. (1976). Chemical examination of the seeds of *Bombax malabaricum*. *Planta Med*, 29, 148–150.

Di Fabio JL, Dutton GG, Moyna P. (1982). The structure of *Chorisia speciosa* gum. *Carbohydr Res*. 99, 41–50.

El-Alfy TS, El-Sawi SA, Sleem A, Moawad DM. (2010). Investigation of flavonoidal content and biological activities of *Chorisia insignis* H.B.K. leaves. *Aust J Basic Appl Sci*. 4, 1334–1348.

EL-Hagrassi AM, Ali MM, Osman AF, Shaaban M. (2011). Phytochemical investigation and biological studies of *Bombax malabricum* flowers. *Nat Prod Res.* 25, 141–151.

Faizi S, Ali M. (1999). Shamimin: A new flavonol C-glycoside from leaves of *Bombax ceiba*. *Planta Med*, 65, 383–385.

Frankham R, Ballou JD, Briscoe DA. (1996). *A Primer of Conservation Genetics.* 2nd edition, Cambridge, UK:The Press Syndicate Of The University Of Cambridge, p. 82.

Gaydou EM, Bianchini J-P, Ralaimanarivo A. (1981). Cyclopropenoid fatty acids in *Malagasy baobab*: *Adansonia grandidieri* (Bombacaceae) seed oil. *Fette Seifen Anstrichmittel*. 84, 468–472.

Gibbs RD. (1974). *Chemotaxonomy of Flowering Plants*. Montreal:McGill-Queens University Press, V.1, p. 516; V.2, p. 1450.

Gopal H, Gupta RK. (1972). Chemical constituents of *Salmalia malabarica* Schott and Endl. flowers. *J Pharm Sci*, 61, 807–808.

Hafez SS, Abdel-Ghani AE, El-Shazly AM. (2003). Pharmacognostical and antibacterial studies of *Chorisia speciosa* St. Hill. flower (Bombacaeae). *Mans J Pharm Sci*. 19, 40–43.

Haq QN, Gomes J. (1973). Studies on water soluble polysaccharide from the roots of *Salmalia malabarica*. *Bangladesh J Sci Ind Res*. 8, 16–20.

Hassan AA. (2009). *Phytochemical and Biological Investigation of Certain Plants Containing Pigments.* A Thesis for the Doctor Degree submitted to Faculty of Pharmacy, Egypt: Mansoura University.

Heywood VH, Brummitt RK, Culham A, Seberg O. (2007). *Flowering Plant Families of the World*. Richmond Hill, Ontario, Canada: Firefly Books.

Joly AB. (1991). *Botany: An Introduction to Plant Taxonomy*. 10th ed., São Paulo: National Publishing Company, p. 462.

Kaimal TN, Gollamudi L. (1972). Changes in lipids of maturing *Ceiba pentandra* seeds. *Phytochemistry*. 11, 1617–1622.

Kishore PH, Reddy MV, Gunasekar D, Caux C, Bodo B. (2003). A new naphthoquinone from *Ceiba pentandra*. *J Asian Nat Prod Res*, 5, 227–230.

Lockett CT, Calvert CC, Grivetti LE. (2000). Energy and micronutrient composition of dietary and medicinal wild plants consumed during drought. Study of rural Fulani, northeastern Nigeria. *Int J Food Sci Nutr*, 51, 195–208.

Lufrano NS, Caffini NO. (1981). Mucilagos foliares de Chorisia H.B.K. (Bombacaceae): Analisis fitoquimico y enfoque quimiotaxonomico. *Phyton.* 40, 13–20.

Macfarlane AF, Mori SA, Purzycki K. (2003). Notes on *Eriotheca longitubulosa* (Bombacaceae), a rare, putatively hawkmoth-pollinated species new to the Guianas. *Brittonia*. 55, 305–316.

Matsuda M, Endo Y, Fushiya S, Endo T, Nozoe S. (1994). Cytotoxic 6-substituted 5,6-dihydro-2H-pyran-2-ones from a Brazilian medicinal plant, Chorisia crispiflora. Heterocycles. 38, 1229–1232.

Mukherjee J, Roy B. (1971). Chemical examination of *Salmalia malabarica*-D Synonym *Bombax malabaricum*-D. *J Ind Chem Soc*, 48, 769–770.

Ngounou FN, Meli AL, Lontsi D, Sondengam BL, Atta-ur-Rahman, Choudhary MI, Malik S, Akhtar F. (2000). New isoflavones from *Ceiba pentandra*. *Phytochemistry*, 54, 107–110.

Niranjan GS, Gupta PC. (1973). Anthocyanins from the flowers of *Bombax malabaricum*. *Planta Med*, 24, 196–199.

Noreen Y, el-Seedi H, Perera P, Bohlin L. (1998). Two new isoflavones from *Ceiba pentandra* and their effect on cyclooxygenase-catalyzed prostaglandin biosynthesis. *J Nat Prod*, 61, 8–12.

Ogbobe O, Ezeukwu AO, Ozoh NG. (1996). Physicochemical properties of seed and fatty acid composition of *Bombax costatum* seed oil. *Riv Ital Sostanze Grasse*. 73, 271–272.

Osman MA. (2004). Chemical and nutrient analysis of baobab (*Adansonia digitata*) fruit and seed protein solubility. *Plant Foods Hum Nutr*, 59, 29–33.

Paula VF. (1995). *Study of Chemical and Plant-insect Interaction* Ochroma lagopus *Swartz (Bombacaceae)*. A Thesis for Master Degree submitted to Universidade Federalde Viçosa, Brazil.

Paula VF, Barbosa LC, Erringto W, Howarth OW, Cruz MP. (2002). Chemical constituents from *Bombacopsis glabra* (Pasq.) A. Robyns: Complete 1H and 13C NMR assignments and X-Ray structure of 5-hydroxy-3,6,7,8,4'-pentamethoxyflavone. *J Braz Chem Soc*. 13, 276–280.

Paula VF, Barbosa LC, Demuner AJ. (1997). The chemistry of the Bombacaceae family. *Quim Nova*. 20, 627–630.

Paula VF, Barbosa LC, Demuner AJ, Campos LA, Pinheiro AL. (1997). Entomotoxicity of the nectar from *Ochroma lagopus* Swartz (Bombacaceae). *Ciência e Cultura*. 49, 274–277.

Paula VF, Barbosa LC, Demuner AJ, Howarth OW, Pilo-Veloso D. (1996). Chemical constituents of *Ochroma lagopus* Swartz. *Quim Nova*. 19, 225–229.

Paula VF, Barbosa LC, Howarth OW, Demuner AJ, Cass QB, Vieira IJ. (1995). Lignans from *Ochroma lagopus* Swartz. *Tetrahedron*. 51, 12453–12462.

Paula VF, Barbosa LC, Pilo-Veloso D, Demuner AJ, Howarth OW. (1998). Chemical constituents of the bark from *Ochroma lagopus* Swartz (Bombacaceae). *Eclet Quim*. 23, 45–57.

Paula VF, Cruz MP. (2006). Chemical constituents of *Bombacopsis glabra* (Bombacaceae). *Quim Nova*. 29, 213–215.

Paula VF, Rocha ME, Barbosa LC, Howarth OW. (2006). Aquatidial, a new bis-norsesquiterpenoid from *Pachira aquatica* Aubl. *J Braz Chem Soc*. 17, 1443–1446.

Perez-Arbelaez E. (1956). *Plantas utiles de Colômbia*. 3rd edition, Bogotá: Camacho Roldan, p. 226.

Petronici C, Bazan E, Panno M, Averna V. (1974). Compozicione acidica e struttura gliceridica dell'olio dei semi di *Chorisia speciosa* St. Hil. *Riv Ital Sostanze Grasse*. 51, 11–15.

Pettersson S, Ervik F, Knudsen JT. (2004). Floral scent of bat-pollinated species: West Africa vs. The New World. *Biol J Linn Soc*. 82, 161–168.

Puckhaber LS, Stipanovic RD. (2001). Revised structure for a sesquiterpene lactone from *Bombax malbaricum*. *J Nat Prod*, 64, 260–261.

Qi Y, Guo S, Xia Z, Xie D. (1996). Chemical constituents of *Gossampinus malabarica* (L.) Merr. (II). *Zhongguo Zhong Yao Za Zhi*, 21, 234–5, 256.

Raffauf RF, Zennie TM, Onan KD, Le Quesne PW. (1984). Funebrine, a structurally novel pyrrole alkaloid, and other γ-hydroxyisoleucine-related metabolites of *Quararibea funebris* (Llave) Vischer (Bombacaceae). *J Org Chem*. 49, 2714–2718.

Rajua TS, Gowda DC, Anjaneyalu VY. (1989). Structural features of alkali-soluble acidic xylans isolated from the bark of *Ceiba pentandra* var. *indica*. *Carbohydr Res*. 191, 331–341.

Ralaimanarivo A, Gaydou EM, Bianchini J-P. (1982). Fatty acid composition of seed oils from six *Adansonia species* with particular reference to cyclopropane and cyclopropene acids. *Lipids*. 17, 1–10.

Ramesh D, Dennis TJ, Shingare MS. (1992). Constituents of *Adansonia digitata* root bark. *Fitoterapia*. 63, 278–279.

Rao KV, Sreeramulu K, Gunasekar D, Ramesh D. (1993). Two new sesquiterpene lactones from *Ceiba pentandra*. *J Nat Prod*, 56, 2041–2045.

Reddy MV, Reddy MK, Gunasekar D, Murthy MM, Caux C, Bodo B. (2003). A new sesquiterpene lactone from *Bombax malabaricum*. *Chem Pharm Bull*. 51, 458–459.

Rizk AM, Al-Nowaihi AS. (1989). *The Phytochemistry of the Horticultural Plants of Qatar*. Oxford:Alden Press, p. 29.

Rizvi SA, Saxena OC. (1974). New glycosides, terpenoids, colouring matters, sugars and fatty compounds from the flowers of *Salmalia malabarica*. *Arzneimittelforschung*, 24, 285–287.

Saleem R, Ahmad SI, Ahmed M, Faizi Z, Zikr-ur-Rehman S, Ali M, Faizi S. (2003). Hypotensive activity and toxicology of constituents from *Bombax ceiba* stem bark. *Biol Pharm Bull*, 26, 41–46.

Saleem R, Ahmad M, Hussain SA, Qazi AM, Ahmad SI, Qazi MH, Ali M, Faizi S, Akhtar S, Husnain SN. (1999). Hypotensive, hypoglycaemic and toxicological studies on the flavonol C-glycoside shamimin from *Bombax ceiba*. *Planta Med*, 65, 331–334.

Saleh NA, El-Sherbeiny AE, El-Sissi HI. (1969). Local plants as potential sources of tannins in Egypt, Part. IV, Aceraceae to Flacourtiaceae. *Qual Plant Mater Veg XVII*. 4, 384–394.

Sankaram AV, Reddy NS, Shoolerya JN. (1981). New sesquiterpenoids of *Bombax malabaricum*. *Phytochemistry*. 20, 1877–1881.

Schuch R, Ahmad F, Mukherjee KD. (1986). Composition of triacylglycerols containing cyclopropene fatty acids in seed lipids of Munguba (*Bombax munguba* Mart.). *J Am Oil Chem Soc*. 63, 778–780.

Scogin R. (1986). Reproductive phytochemistry of Bombacaceae: Floral anthocyanins and nectar constituents. *Aliso*. 11, 377–385.

Seshadri V, Bhatta AK, Rangaswami S. (1971). Phenolic compounds of *Bombax malabaricum* (root-bark). *Curr Sci*. 40, 630–631.

Seshadri V, Bhatta AK, Rangaswami S. (1973). Phenolic compounds of *Bombax malabaricum*. *Indian J Chem*. 11, 825–827.

Seshadri V, Bhatta AK, Rangaswami S. (1976). A new crystalline lactone from *Bombax malabaricum*. *Indian J Chem B*, 14, 616–617.

Shahat AA. (2006). Procyanidins from *Adansonia digitata*. *Pharm Biol*. 44, 445–450.

Sharma OP. (1993). *Plant Taxonomy*. 1st ed., West Patel Nagar, New Delhi: Tata McGraw Hill Company Limited, p. 236–238.

Shibatani M, Hashidoko Y, Tahara, S. (1999a). A major fungitoxin from *Pachira aquatica* and its accumulation in outer bark. *J Chem Ecol*. 25, 347–353.

Shibatani M, Hashidoko Y, Tahara S. (1999b). Accumulation of isohemigossypolone and its related compounds in the inner bark and heartwood of diseased *Pachira aquatica*. *Biosci Biotech Bioch* 63, 1777–1780.

Shukla YN, Dubey S, Jain SP, Kumar S. (2001). Chemistry, biology and uses of *Adansonia digitata*-A review. *J Med Aromatic Pl Sci*. 23, 429–434.

Sichaem J, Siripong P, Khumkratok S, Tip-Pyang S. (2010). Chemical constituents from the roots of *Bombax anceps*. *J Chil Chem Soc*. 55, 325–327.

Sipra-Dan S, Dan S. (1986). Phytochemical study of *Adansonia digitata*, *Coccoloba excoriata*, *Psycotria adenophylla* and *Schleichera oleosa*. *Fitoterapia*. 57, 445–446.

Sood RP, Suri KA, Suri OP, Dhar KL, Atal CK. (1982). Sesquiterpene lactone from *Salmalia malbarica*. *Phytochemistry*. 21, 2125–2126.

Ueda H, Kaneda N, Kawanishi K, Alves SM, Moriyasu M. (2002). A new isoflavone glycoside from *Ceiba pentandra* (L.) Gaertner. *Chem Pharm Bull*, 50, 403–404.

Vazquez E, Martinez EM, Cogordan JA, Delgado G. (2001). Triterpenes, phenols, and other constituents from the leaves of *Ochroma pyramidale* (Balsa Wood, Bombacaceae). Preferred conformations of 8-C-β-D-glucopyranosyl-apigenin (vitexin). *Rev Soc Quím Méx*. 45, 254–258.

Versiani MA. (2004). *Studies in the Chemical Constituents of* Bombax ceiba *and* Cuscuta reflexa. A Thesis for the Doctor Degree submitted to H.E.J Research Institute of Chemistry, Karachi University, Pakistan.

Wu J, Zhang X, Zhang S, Xuan L. (2008). Three novel compounds from the flowers of *Bombax malabaricum*. *Helv Chim Acta*. 91, 136–143.

Yazzie D, VanderJagt DJ, Pastuszyn A, Okolo A, Glew RH. (1994). The amino acid and mineral content of baobab (*Adansonia digitata* L.) leaves. *J Food Compos Anal*. 7, 189–193.

Zennie TM, Cassady JM. (1990). Funebradiol, a new pyrrole lactone alkaloid from *Quararibea funebris* flowers. *J Nat Prod*, 53, 1611–1614.

Zennie TM, Cassady JM, Raffauf RF. (1986). Funebral, a new pyrrole lactone alkaloid from *Quararibea funebris*. *J Nat Prod*, 49, 695–698.

Zhang X, Zhu H, Zhang S, Yu Q, Xuan L. (2007). Sesquiterpenoids from *Bombax malabaricum*. *J Nat Prod*, 70, 1526–1528.