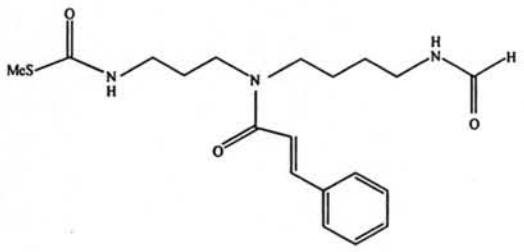
CHAPTER II

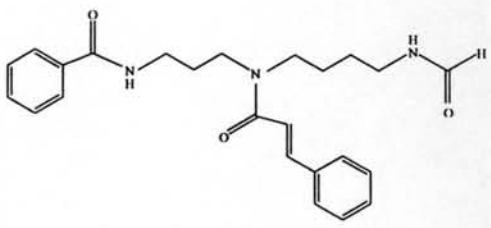
HISTORICAL

Meliaceae contains a wide range of chemical compounds. Some of these compounds, such as the triterpenoids, are biosynthesized from the mevalonate pathway. Other compounds are biosynthesized from the shikimate pathyway, i.e. flavonoids, coumarins, lignans and flavaglines.

The only information on alkaloid content in genus *Chisocheton* was reported by Tzouros in which two spermidine alkaloids, Chisitine 1 **[1.1]** and Chisitine 2 **[1.2]**, were isolated from the leaves of *C. weinlandii*.



[1.1]



[1.2]

Reviews of the triterpenoid constituents of *Chisocheton* species, dammarane-type, aromadendrane-type sesquiterpenes and together with a review of flavagline derivatives, are present herein.

Chemical constituents of *Chisocheton* spp.

Chemical investigations of a number of *Chisocheton* spp. have shown them to be a good source of triterpenoids. The literature reviews of triterpenoids from *C. paniculatus*, *C. microcarpus* and *C. macrophyllus* are summarized in **Table 2**.

Table 2 The distribution of triterpenoids in *Chisocheton* spp.

Compounds	Source	Part	References
Apo-tirucallol triterpenes Compound A **[1.3]**	*Chisocheton paniculatus*	Wood	Connolly *et al.*, 1979

Table 2 The distribution of triterpenoids in *Chisocheton* spp. (continued)

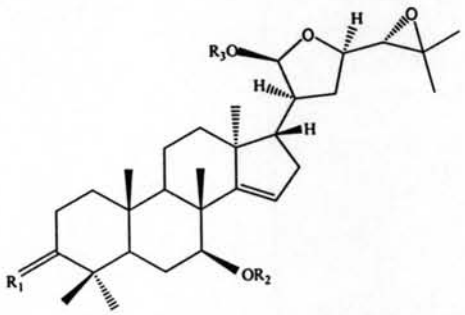
Compounds	Source	Part	References
Compound B [**1.4**]	*C. paniculatus*	Wood	Connolly *et al.*, 1979
Compound C [**1.5**]	*C. paniculatus*	Wood	Connolly *et al.*, 1979
Compound D [**1.6**]	*C. paniculatus*	Wood	Connolly *et al.*, 1979
Paniculatin B [**1.7**]	*C. paniculatus*	Root wood	Yadav *et al.*, 1999a, 1999b
Paniculatin C [**1.8**]	*C. paniculatus*	Root wood	Yadav *et al.*, 1999a, 1999b
Paniculatin D [**1.9**]	*C. paniculatus*	Root wood	Yadav *et al.*, 1999a, 1999b
Tirucallane triterpenes Arunachalin [**1.10**]	*C. paniculatus*	Root wood	Yadav *et al.*, 1999a, 1999b, 1999c
Tetranortriterpenoids 6α-Acetoxyazadirone (Paniculatin) [**1.11**]	*C. paniculatus*	Fruits	Saikia *et al.*, 1978; Bhattacharyya *et al.*, 2004
	C. paniculatus	Seeds	Chatterjee *et al.*, 1989
	C. paniculatus	Root wood	Yadav *et al.*, 1999a
6α-Acetoxyepoxy azadirone [**1.12**]	*C. paniculatus*	Seeds	Chatterjee *et al.*, 1989
6α-Acetoxygedunin [**1.13**]	*C. paniculatus*	Seeds	Connolly *et al.*, 1979; Chatterjee *et al.*, 1989
6α-Acetoxynimbinin [**1.14**]	*C. paniculatus*	Seeds	Connolly *et al.*, 1979
6α-Acetoxy-16-oxoazadirone [**1.15**]	*C. paniculatus*	Fruits	Saikia *et al.*, 1978

Table 2 The distribution of triterpenoids in *Chisocheton* spp. (continued)

Compounds	Source	Part	References
5α,7α,13α,17α-7-Acetyloxy-21,23-γ-lactone-4,4,8-trimethyl-24-norchola-1,14,20,22-tetraene-5-one [**1.16**]	*C. microcarpus*	Leaves	Gunning *et al.*, 1994
Compound E [**1.17**]	*C. paniculatus*	Seeds	Connolly *et al.*, 1979
Compound F [**1.18**]	*C. paniculatus*	Seeds	Connolly *et al.*, 1979
Compound G [**1.19**]	*C. paniculatus*	Seeds	Connolly *et al.*, 1979
5α,7α,13α,17α-7-Deacetyloxy-21,23-γ-lactone-4,4,8-trimethyl-24-norchola-1,14,20,22-tetraene-5-one [**1.20**]	*C. microcarpus*	Leaves	Gunning *et al.*, 1994
1,2-Dihydro-6α-acetoxyazadirone [**1.21**]	*C. paniculatus*	Fruits	Bordoloi *et al.*, 1993
6α,7α-Dihydroxymeliaca-1,14,20,22-tetraene-3,14-dione [**1.22**]	*C. paniculatus*	Fruits	Saikia *et al.*, 1978
Gedunin [**1.23**]	*C. paniculatus*	Seeds	Connolly *et al.*, 1979
17β-Hydroxy-6α-acetoxyazadiradione [**1.24**]	*C. paniculatus*	Seeds	Connolly *et al.*, 1979
	C. paniculatus	Seeds	Chatterjee *et al.*, 1989
17β-Hydroxy-6α-acetoxynimbinin [**1.25**]	*C. paniculatus*	Seeds	Connolly *et al.*, 1979
Vilasinin 1,3-diacetate [**1.26**]	*C. paniculatus*	Wood	Connolly *et al.*, 1979
Oleanane triterpenes Moronic acid [**1.27**]	*C. macrophyllus*	Leaves	Inada *et al.*, 1993
Lupane triterpenes Betulonic acid [**1.28**]	*C. macrophyllus*	Leaves	Inada *et al.*, 1993

Table 2 The distribution of triterpenoids in *Chisocheton* spp. (continued)

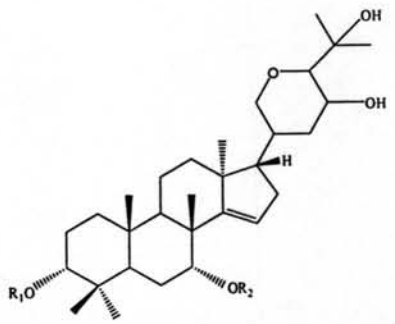
Compounds	Source	Part	References
Dammarane triterpenes 24-Hydroxydammara-20,25-dien-3-one [**1.29**]	*C. macrophyllus*	Leaves	Inada *et al.*, 1993



Compound A [**1.3**] : R_1 = O, R_2 = H, R_3 = Ac

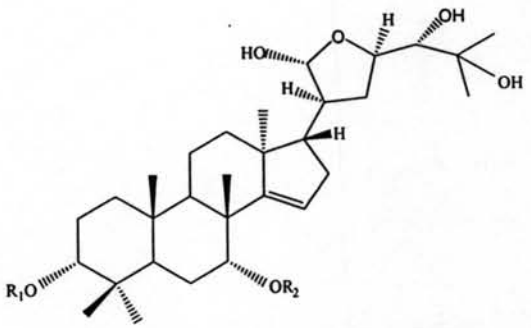
Compound D [**1.6**] : R_1 = H, α-OH, R_2 = H, R_3 = Ac

Paniculatin B [**1.7**] : R_1 = H, α-OH, R_2 = Ac, R_3 = H



Compound B [**1.4**] : R_1 = H, α-OAc, R_2 = H

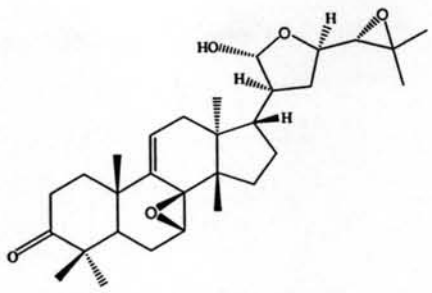
Paniculatin D [**1.9**] : R_1 = H, α-OH, R_2 = Ac



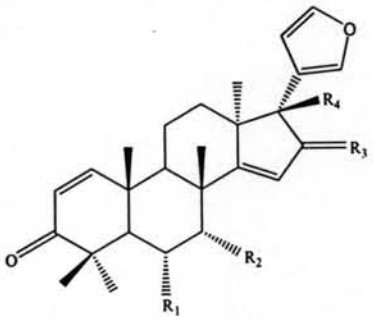
Compound C [**1.5**] : R_1 = H, α-OAc, R_2 = H, R_3 = OH

Paniculatin C [**1.8**] : R_1 = H, α-OH, R_2 = Ac, R_3 = OH

Figure 3. Chemical structures of triterpenoids found in *Chisocheton* spp.



Arunachalin [**1.10**]



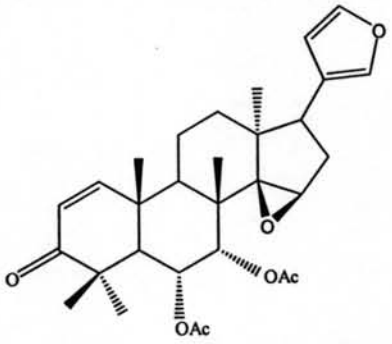
6α-Acetoxyazadirone (Paniculatin) [**1.11**] : R_1 = OAc, R_2 = OAc, R_3 = H_2, R_4 =H

6α-Acetoxy-16-oxoazadirone [**1.15**] : R_1 = OAc, R_2 = OAc, R_3 = O, R_4 =H

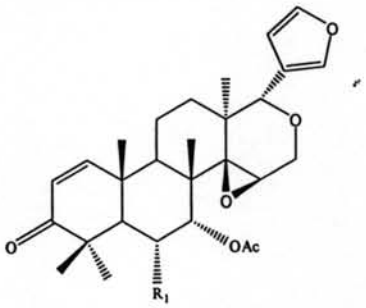
6α,7α-Dihydroxymeliaca-1,14,20,22-tetraene-3,14-dione [**1.22**]

: R_1 = OH, R_2 = OH, R_3 = O, R_4 =H

17β-Hydroxy-6α-acetoxyazadiradione [**1.24**] : R_1 = OAc, R_2 = OAc, R_3 = O, R_4 =OH



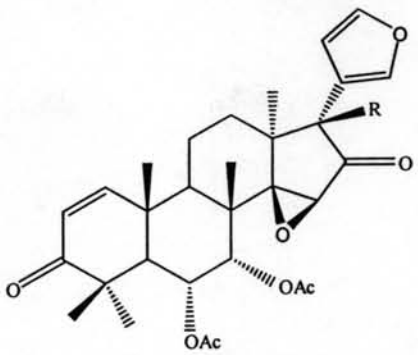
6α-Acetoxyepoxyazadirone [**1.12**]



6α-Acetoxygedunin [**1.13**] : R_1 = OAc

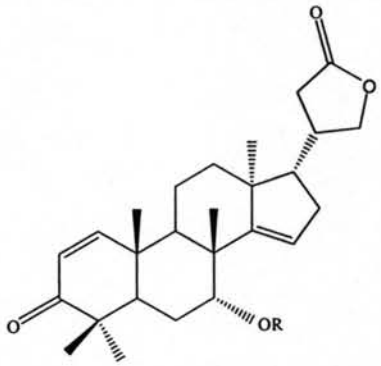
Gedunin [**1.23**] : R_1 = H

Figure 3. Chemical structures of triterpenoids found in *Chisocheton* spp. (continued)



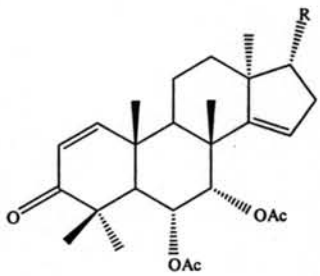
6α-Acetoxynimbinin [**1.14**] : R = H

17β-Hydroxy-6α-acetoxynimbinin [**1.25**] : R = OH

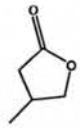


5α,7α,13α,17α-7-Acetyloxy-21,23-γ-lactone-4,4,8-trimethyl-24-norchola-1,14,20,22-tetraene-5-one [**1.16**] : R = Ac

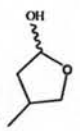
5α,7α,13α,17α-7-Deacetyloxy-21,23-γ-lactone-4,4,8-trimethyl-24-norchola-1,14,20,22-tetraene-5-one [**1.20**] : R = H



Compound E [**1.17**] : R =



Compound F [**1.18**] : R =



Compound G [**1.19**] : R =

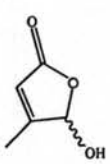
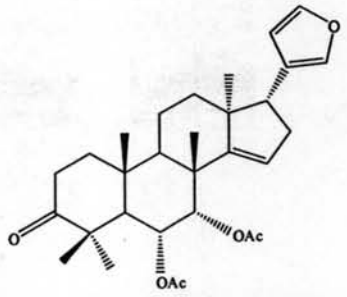
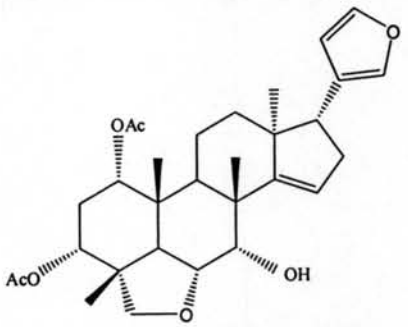


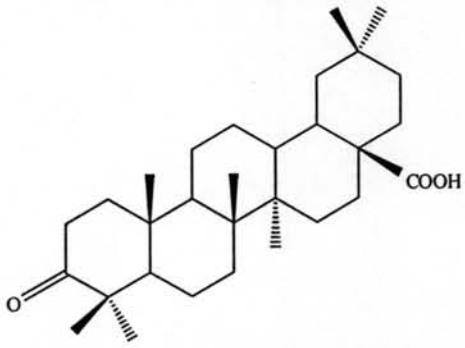
Figure 3. Chemical structures of triterpenoids found in *Chisocheton* spp. (continued)



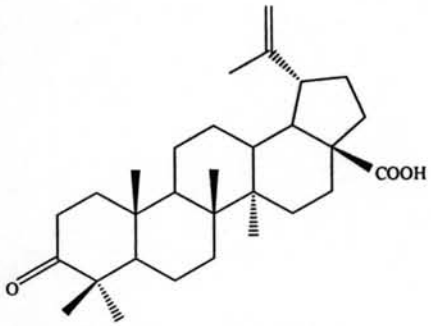
1,2-Dihydro-6α-acetoxyazadirone [**1.21**]



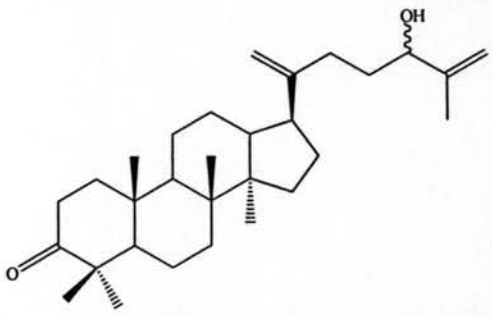
Vilasinin 1,3-diacetate [**1.26**]



Moronic acid [**1.27**]



Betulonic acid [**1.28**]

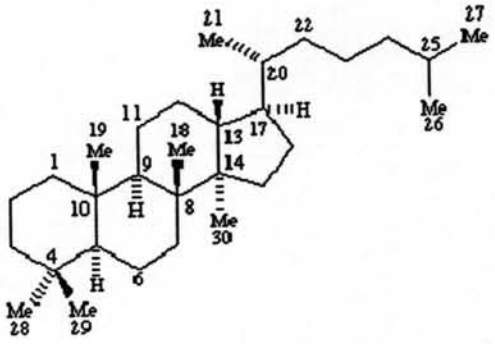


24-Hydroxydammara-20,25-dien-3-one [**1.29**]

Figure 3. Chemical structures of triterpenoids found in *Chisocheton* spp. (continued)

Dammarane – type triterpenoid compounds

Dammarane-type triterpenoid compounds are found in almost every plant family, including Meliaceae. They represent tetracyclic triterpenes as shown below.



The distribution of dammarane-type triterpenes in the Meliaceae is summarized in **Table 3** and their chemical structures are shown in **Figure 4.**

Table 3. Distribution of dammarane-type triterpenoids in the Meliaceae.

Compounds	Source	Part	References
23(24→25)*Abeo*-20*R*,24-dihydroxy dammaran-3-one [**2.1**]	*Dysoxylum cauliflorum*	Fruits	Huang *et al.*, 1999
Aglaiol [**2.2**]	*Aglaia odorata*	Leaves	Shiengthong *et al.*, 1965
	Cabralea polytricha	Fruits	Cascon and Brown, 1972
Aglaiondiol [**2.3**]	*Aglaia odorata*	Leaves	Shiengthong *et al.*, 1974
Aglaitriol (24*R*) [**2.4**]	*Aglaia odorata*	Leaves	Shiengthong *et al.*, 1974
Aglaitriol (24*S*) [**2.5**]	*Aglaia odorata*	Leaves	Shiengthong *et al.*, 1974

Table 3. Distribution of dammarane-type triterpenoids in the Meliaceae. (continued)

Compounds	Source	Part	References
Aglinin A [**2.6**]	*Aglaia lawii*	Leaves	Mohamad *et al.*, 1999
	Amoora yunnanensis	Bark	Luo *et al.*, 2000
Aglinin B [**2.7**]	*Aglaia lawii*	Leaves	Mohamad *et al.*, 1999
Aglinin C [**2.8**]	*Aglaia tomentosa*	Leaves	Mohamad *et al.*, 1999
Aglinin D [**2.9**]	*Aglaia tomentosa*	Leaves	Mohamad *et al.*, 1999
Cabraleadiol [**2.10**]	*Aglaia crassinervia*	Bark	Su *et al.*, 2006
	Aglaia lawii	Stem bark	Qiu *et al.*, 2001
	Aglaia tomentosa	Leaves	Mohamad *et al.*, 1999
	Amoora cucullata	Stem bark	Haque *et al.*, 1995
	Amoora yunnanensis	Leaves	Luo *et al.*, 2000
	Cabralea eichleriana	Wood	Rao *et al.*, 1975
	C. polytricha	Fruits	Cascon and Brown, 1972
	Dysoxylum malabaricum	Stem bark	Hisham *et al.*, 1996
Cabraleadiol 3-acetate [**2.11**]	*Aglaia lawii*	Stem bark	Qiu *et al.*, 2001
	Aglaia tomentosa	Leaves	Mohamad *et al.*, 1999
	Cabralea eichleriana	Wood	Rao *et al.*, 1975
	C. polytricha	Fruits	Cascon and Brown, 1972
Cabraleahydroxylactone [**2.12**]	*Aglaia crassinervia*	Bark	Su *et al.*, 2006
	Cabralea eichleriana	Wood	Rao *et al.*, 1975
	C. polytricha	Fruits	Cascon and Brown, 1972
	Amoora yunnanensis	Bark	Luo *et al.*, 2000
Cabralealactone [**2.13**]	Aglaia *leucophylla*	Stem bark	Benosman *et al.*, 1994
	Aglaia tomentosa	Leaves	Mohamad *et al.*, 1999
	Cabralea eichleriana	Wood	Rao *et al.*, 1975
	C. polytricha	Fruits	Cascon and Brown, 1972

Table 3. Distribution of dammarane-type triterpenoids in the Meliaceae. (continued)

Compounds	Source	Part	References
Cabralealactone [**2.13**]	*Amoora cucullata*	Stem bark	Haque *et al.*, 1996
	Dysoxylum cauliflorum	Fruits	Huang *et al.*, 1999
Cabralealactone 3-acetate [**2.14**]	*Aglaia tomentosa*	Leaves	Mohamad *et al.*, 1999
Cabraleone [**2.15**]	*Aglaia lawii*	Leaves	Mohamad *et al.*, 1999
	Aglaia tomentosa	Bark	Mohamad *et al.*, 1999
	Aglaia leucophylla	Stem bark	Benosman *et al.*, 1994
	Aglaia silvestris	Fruits	Hwang *et al.*, 2004
	Aglaia rubiginosa	Leaves	Rivero-Cruz *et al.*, 2004
	Amoora yunnanensis	Bark	Luo *et al.*, 2000
	Amoora cucullata	Stem bark	Haque *et al.*, 1995
	Cabralea eichleriana	Wood	Rao *et al.*, 1975
	C. polytricha	Fruits	Cascon and Brown, 1972
	Dysoxylum richii	Fruits	Aalbersberg and Singh, 1991
	D. muellerii	Wood	Mulholland and Naidoo, 2000
20*S*,23*R*,24*R*-23-Chloro-20,24-epoxy-dammarane-3α,24,25-triol 3-acetate [**2.16**]	*Amoora yunnanensis*	Bark	Luo *et al.*, 2000
5α-Dammar-20-ene-3β-24,25-triol [**2.17**]	*Aglaia odorata*	Leaves	Boar and Damps, 1977
Dammarenolic acid [**2.18**]	*Cabralea eichleriana*	Wood	Rao *et al.*, 1975
	Aglaia rubiginosa	Leaves	Rivero-Cruz *et al.*, 2004

Table 3. Distribution of dammarane-type triterpenoids in the Meliaceae. (continued)

Compounds	Source	Part	References
11α,20ξ-Dihydroxydammar-24-ene-3-one [**2.19**]	*Astrotrichilia asterotricha*	Wood and bark	Mulholland *et al.*, 1994
24,25-Dihydroxy-dammar-20-en-3-one [**2.20**]	*Aglaia odorata*	Leaves	Boar and Damps, 1977
	Amoora yunnanensis	Bark	Luo *et al.*, 2000
(20*S*,23*E*)-20,25-Dihydroxy-3,4-secodammara-4(28),23-dienoic acid [**2.21**]	*Aglaia rubiginosa*	Leaves	Rivero-Cruz *et al.*, 2004
(20*S*,23*E*)-20,25-Dihydroxy-3,4-secodammara-4(28),23-dienoic acid methyl ester [**2.22**]	*Aglaia rubiginosa*	Leaves	Rivero-Cruz *et al.*, 2004
Dymalol [**2.23**]	*Dysoxylum malaaricum*	Leaves	Govindachari *et al.*, 1994
Eichlerialactone [**2.24**]	*Amoora yunnanensis*	Bark	Luo *et al.*, 2000
	Cabralea canjerana	Branches	De Campos Braga *et al.*, 2006
	C. eichleriana	Wood	Rao *et al.*, 1975
	Dysoxylum cauliflorum	Fruits	Huang *et al.*, 1999
	D. richii	Leaves	Singh and Aalbersberg, 1992
Eichlerianic acid [**2.25**]	*Aglaia lawii*	Leaves	Mohamad *et al.*, 1999
	Aglaia leucophylla	Stem bark	Benosman *et al.*, 1994
	Aglaia elliptica	Stem	Cui *et al.*, 1997
	Dysoxylum richii	Fruits	Aalbersberg and Singh, 1991

Table 3. Distribution of dammarane-type triterpenoids in the Meliaceae. (continued)

Compounds	Source	Part	References
Eichlerianic acid [**2.25**]	*Cabralea canjerana*	Stem and branches	De Campos Braga *et al.*, 2006
	C. eichleriana	Wood	Rao *et al.*, 1975
3-*Epi*- Cabraleahydroxy lactone [**2.26**]	*Aglaia crassinervia*	Bark	Su *et al.*, 2006
3-*Epi*-ocotillol [**2.27**]	*Aglaia lawii*	Leaves	Mohamad *et al.*, 1999
	Aglaia foveolata	Bark	Roux *et al.*, 1998
	Aglaia crassinervia	Bark	Su *et al.*, 2006
24ξ,25-Epoxy-5α-dammar-20-en-3-one [**2.28**]	*Aglaia odorata*	Leaves	Boar and Damps, 1977
20*S*,24-Epoxy-24,25-dihydroxydammar-3-one [**2.29**]	*Amoora yunnanensis*	Bark	Luo *et al.*, 2000
20*S*,24*S*-Epoxy-7β,25-dihydroxy-3,4-secodammar-4(28)-en-3-oic acid [**2.30**]	*Cabralea canjerana*	Stem	De Campos Braga *et al.*, 2006
20*S*,24*S*-Epoxy-4-hydroxy-3,4-seco-dammar-25(26)-en-3-oic acid [**2.31**]	*Dysoxylum richii*	Leaves	Singh and Aalbersberg, 1992
20*S*,24*S*-Epoxy-25-hydroxydammaran-3-one [**2.32**]	*Aglaia elaeagnoidea*	Bark	Fuzzati *et al.*, 1996
20*S*,24*S*-Epoxy-25-hydroxymethyldammaran-3-one [**2.33**]	*Aglaia elaeagnoidea*	Bark	Fuzzati *et al.*, 1996

Table 3. Distribution of dammarane-type triterpenoids in the Meliaceae. (continued)

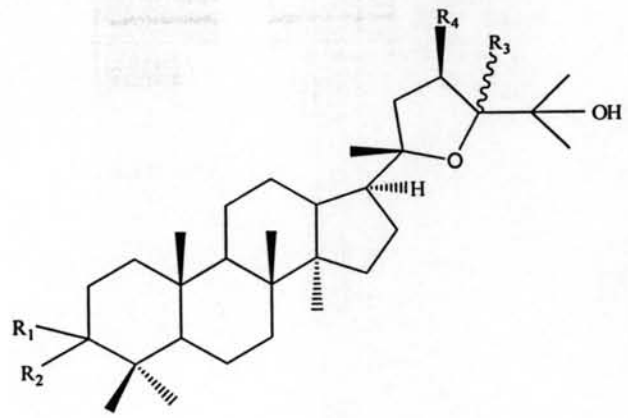
Compounds	Source	Part	References
20*S*,24*S*-Epoxy-7β,15α,25-trihydroxy-3,4-secodammar-4(28)-en-3-oic acid [**2.34**]	*Cabralea canjerana*	Stem	De Campos Braga *et al.*, 2006
20*S*,24*S*-Epoxy-7β,22ξ,25-trihydroxy-3,4-secodammar-4(28)-en-3-oic acid [**2.35**]	*C. canjerana*	Stem	De Campos Braga *et al.*, 2006
20*S*,24-Epoxy-25,26,27-trisnor-24-oxo-3,4-seco-4(28)-dammaren-3-oic acid [**2.36**]	*Amoora yunnanensis*	Bark	Luo *et al.*, 2000
	Dysoxylum richii	Leaves	Singh and Aalbersberg, 1992
Ethyl eichlerianoate [**2.37**]	*D. cauliflorum*	Stem bark	Benosman *et al.*, 2000
Foveolin A [**2.38**]	*Aglaia lawii*	Leaves	Mohamad *et al.*, 1999
	Aglaia foveolata	Bark	Roux *et al.*, 1998
Foveolin B [**2.39**]	*Aglaia foveolata*	Bark	Roux *et al.*, 1998
Methyl richenoate [**2.40**]	*Dysoxylum richii*	Fruits	Aalbersberg *et al.*, 1991
Ocotillol [**2.41**]	*Aglaia leucophylla*	Stem bark	Benosman *et al.*, 1994
	Aglaia elliptica	Stem	Cui *et al.*, 1997
	Cabralea polytricha	Fruits	Cascon and Brown, 1972
	Dysoxylum cauliflorum	Fruits	Huang *et al.*, 1999
Ocotillone [**2.42**]	*Aglaia leucophylla*	Stem bark	Benosman *et al.*, 1994
	Aglaia silvestris	Fruits	Hwang *et al.*, 2004
	Aglaia rubiginosa	Leaves	Rivero-Cruz *et al.*, 2004

Table 3. Distribution of dammarane-type triterpenoids in the Meliaceae. (continued)

Compounds	Source	Part	References
Ocotillone [**2.42**]	*Amoora yunnanensis*	Bark	Luo *et al.*, 2000
	Cabralea canjerana	Stem and branches	Braga *et al.*, 2006
	C. eichleriana	Wood	Rao *et al.*, 1975
	Dysoxylum malaaricum	Leaves	Govindachari *et al.*, 1994
	D. richii	Fruits	Aalbersberg and Singh, 1991
	D. cauliflorum	Fruits	Huang *et al.*, 1999
Richenoic acid [**2.43**]	*Dysoxylum richii*	Fruits	Aalbersberg and Singh, 1991
Richenol [**2.44**]	*Dysoxylum richii*	Fruits	Aalbersberg and Singh, 1991
Richenone [**2.45**]	*D. richii*	Fruits	Aalbersberg and Singh, 1991
	D. muellerii	Wood	Mulholland and Naidoo, 2000
Shoreic acid [**2.46**]	*Aglaia lawii*	Leaves	Mohamad *et al.*, 1999
	Aglaia elliptica	Stem	Cui *et al.*, 1997
	Aglaia rubiginosa	Leaves	Rivero-Cruz *et al.*, 2004
	Amoora yunnanensis	Bark	Luo *et al.*, 2000
	Cabralea canjerana	Stem and branches	De Campos Braga *et al.*, 2006
	C. eichleriana	Wood	Rao *et al.*, 1975
	Dysoxylum malabaricum	Leaves	Govindachari *et al.*, 1994
	D. richii	Fruits	Aalbersberg and Singh, 1991

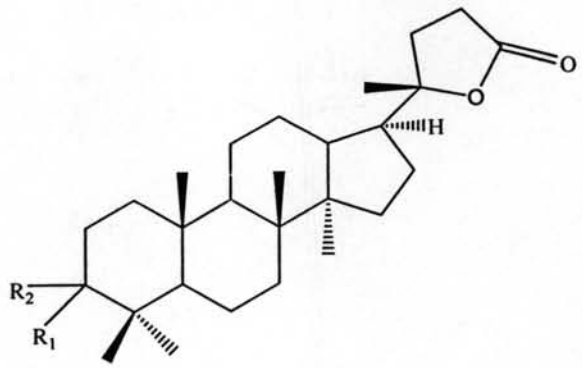
Table 3. Distribution of dammarane-type triterpenoids in the Meliaceae. (continued)

Compounds	Source	Part	References
Shoreic acid [**2.46**]	*D. cauliflorum*	Fruits	Huang *et al.*, 1999
3α,11α,20ξ-Trihydroxy dammar-24-ene [**2.47**]	*Aglaia asterotricha*	Wood and bark	Mulholland *et al.*, 1994



	R_1	R_2	R_3	R_4
Aglinin C **[2.8]**	β-H	α-OH	OH	H
Aglinin D **[2.9]**		=O	OH	H
Cabraleadiol **[2.10]**	H	H	β-H	H
Cabraleadiol 3-acetate **[2.11]**	β-H	α-OAc	β-H	H
Cabraleone **[2.15]**		=O	β-H	H
20*S*,23*R*,24*R*-23-Chloro-20,24-epoxy-dammarane-3α,24,25-triol 3-acetate **[2.16]**	β-H	α-OAc	α-OH	β-Cl
3-Epi-ocotillol **[2.27]**	β-H	α-OH	β-H	H
20*S*,24-Epoxy-24,25-dihydroxydammar-3-one **[2.29]**		=O	OH	H
20*S*,24*S*-Epoxy-25-hydroxy-dammaran-3-one **[2.32]**		=O	α-H	H
20*S*,24*S*-Epoxy-25-hydroxy-methyldammaran-3-one **[2.33]**		=O	α-H	H
Ocotillol **[2.41]**	α-H	β-OH	β-H	H
Ocotillone **[2.42]**		=O	β-H	H
20*S*,23*R*,24*S*-23-Chloro-20,24-epoxy-dammarane-3α,24,25-triol 3-acetate **[2.36]**	β-H	α-OAc	β-OH	β-Cl

Figure 4. Chemical structures of dammarane – type triterpenoids in the Meliaceae

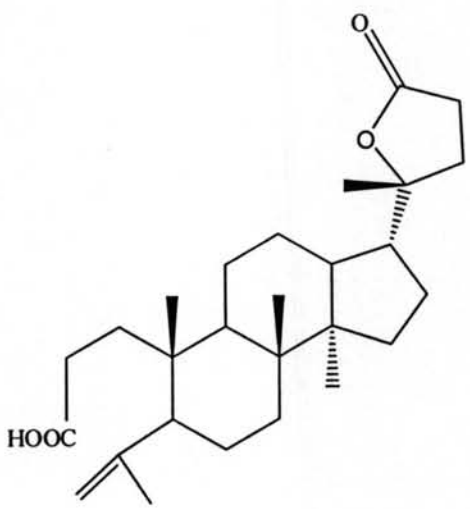


Cabraleahydroxylactone [**2.12**] :R_1, R_2 = H, α-OH

Cabralealactone [**2.13**] :R_1, R_2 = =O

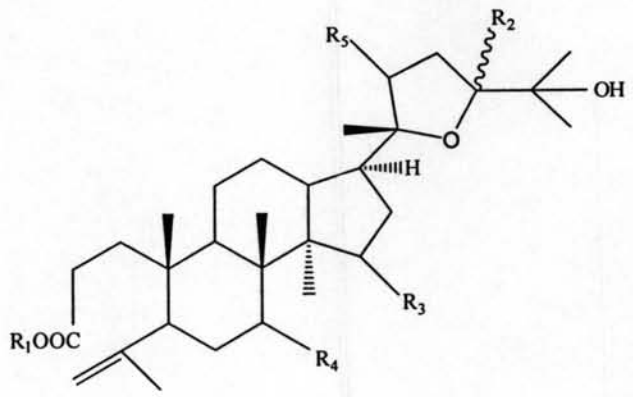
Cabralealactone 3-acetate [**2.14**] :R_1, R_2 = H, α-OAc

3-*Epi*-cabraleahydroxylactone [**2.26**] :R_1, R_2 = H, β-OH



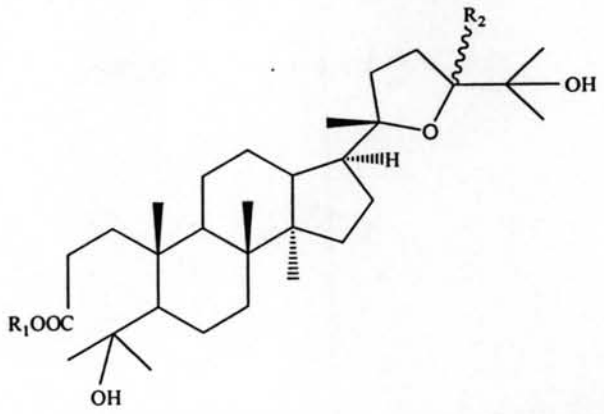
Eichlerialactone [**2.24**]

Figure 4. Chemical structures of dammarane – type triterpenoids in the Meliaceae (continued)



	R_1	R_2	R_3	R_4	R_5
Aglinin A [**2.6**]	H	OH	H	H	H
Eichlerianic acid, 24*S* [**2.25**]	H	H	H	H	H
20*S*,24*S*-Epoxy-7β,25-dihydroxy-3,4-secodammar-4(28)-en-3-oic acid [**2.30**]	H	α-H	H	β-OH	H
20*S*,24*S*-Epoxy-7β,15α,25-trihydroxy-3,4-secodammar-4(28)-en-3-oic acid [**2.34**]	H	α-H	α-OH	β-OH	H
20*S*,24*S*-Epoxy-7β,22ξ,25-trihydroxy-3,4-secodammar-4(28)-en-3-oic acid [**2.35**]	H	α-H	H	β-OH	OH
Ethyl eichlerianoate, 24S [**2.37**]	CH_2CH_3	H	H	H	H
Shoreic acid, 24*R* [**2.46**]	H	H	H	H	H

Figure 4. Chemical structures of dammarane – type triterpenoids in the Meliaceae (continued)

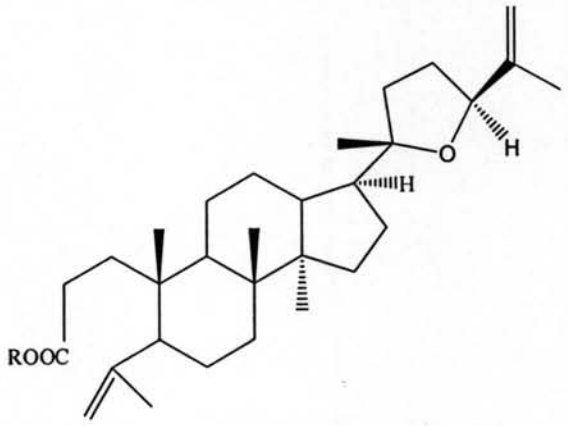


Aglinin B [**2.7**] :R_1= H, R_2 = OH

Dymalol, 24*S* [**2.23**] :R_1 = CH_3, R_2 =H

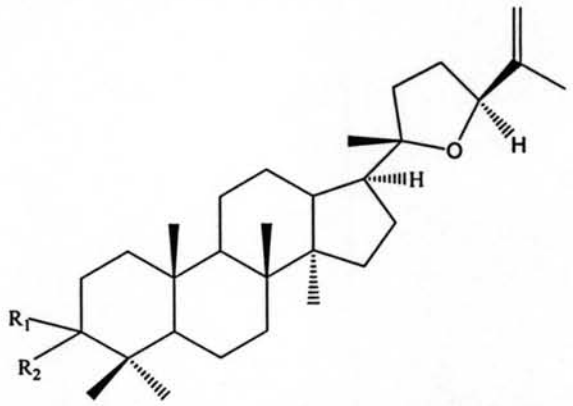
Foveolin A, 24*S* [**2.38**] :R_1= H, R_2 = H

Foveolin B, 24*R* [**2.39**] :R_1= H, R_2 = H



Methyl richenoate [**2.40**] :R = CH_3

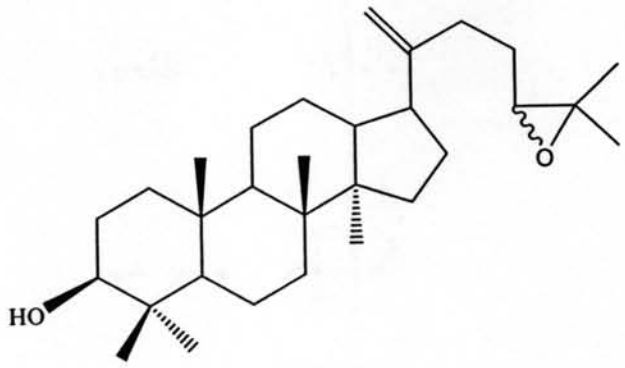
Richenoic acid [**2.43**] :R = H



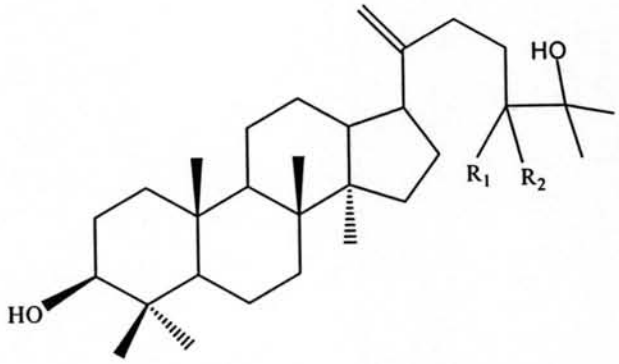
Richenol [**2.44**] :R_1,R_2 = H, β-OH

Richenone [**2.45**] :R_1,R_2 = =O

Figure 4. Chemical structures of dammarane – type triterpenoids in the Meliaceae (continued)



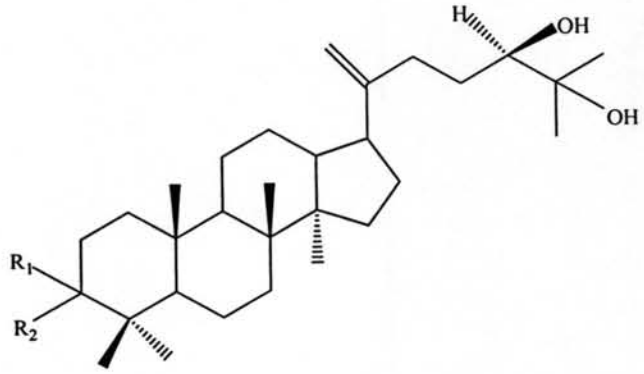
Aglaiol [**2.2**]



Aglaiondiol [**2.3**] :R_1,R_2 = =O

Aglaitriol (24*R*) [**2.4**] :R_1,R_2 = H,OH

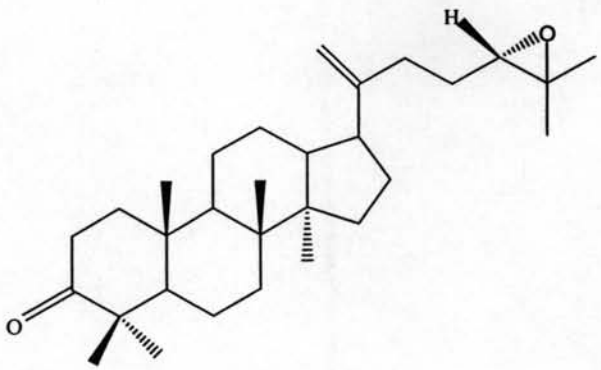
Aglaitriol (24*S*) [**2.5**] :R_1,R_2 = H,OH



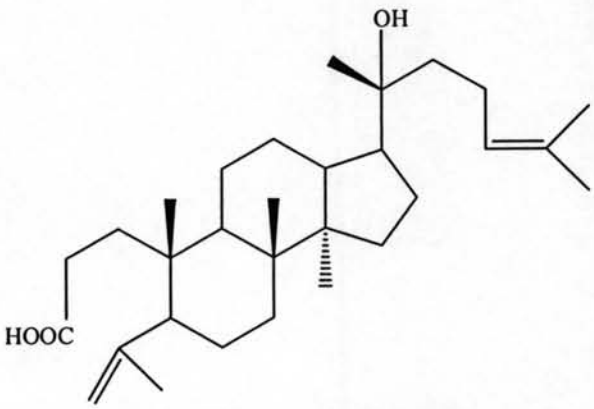
5α-Dammar-20-ene-3β-24,25-triol [**2.17**] :R_1,R_2 =H, β-OH

24,25-Dihydroxy-dammar-20-en-3-one [**2.20**] :R_1,R_2 = =O

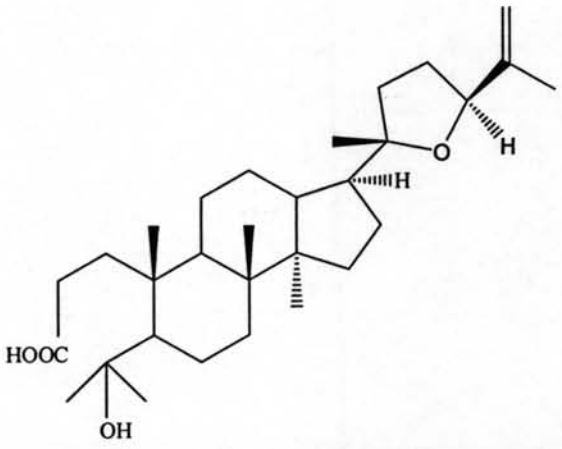
Figure 4. Chemical structures of dammarane – type triterpenoids in the Meliaceae (continued)



24ξ,25-Epoxy-5α-dammar-20-en-3-one **[2.28]**

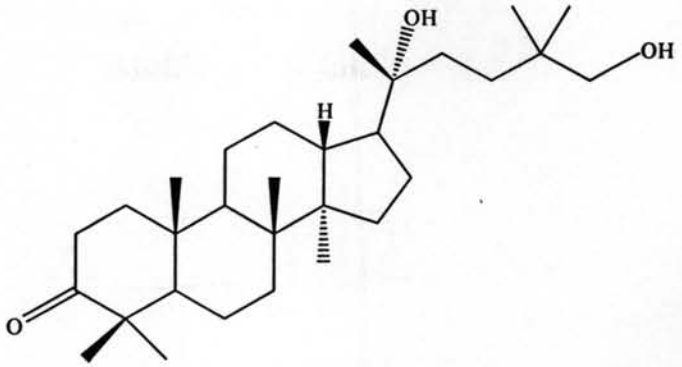


Dammarenolic acid **[2.18]**

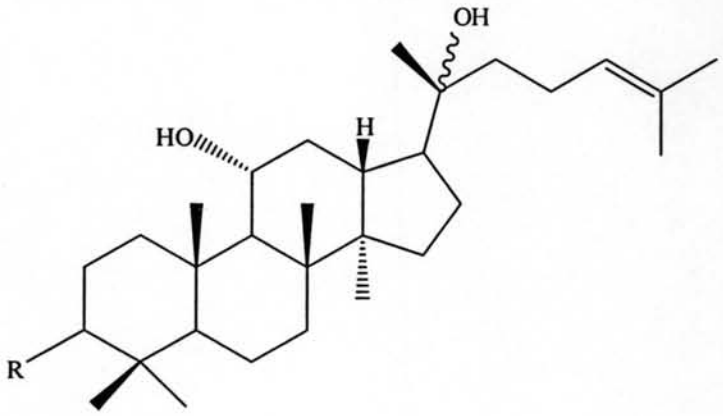


20*S*,24*S*-Epoxy-4-hydroxy-3,4-seco-dammar-25(26)-en-3-oic acid **[2.31]**

Figure 4. Chemical structures of dammarane – type triterpenoids in the Meliaceae (continued)

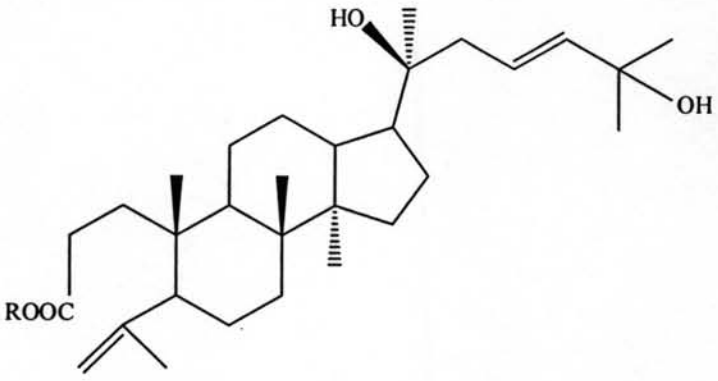


23(24→25)*Abeo*-20*R*,24-dihydroxydammaran-3-one [**2.1**]



11α,20ξ-Dihydroxydammar-24-ene-3-one [**2.19**] :R = =O

3α,11α,20ξ-Trihydroxydammar-24-ene [**2.47**] :R = α-OH, β-H



(20*S*,23*E*)-20,25-Dihydroxy-3,4-secodammara-4(28),23-dienoic acid [**2.21**]
:R = H

(20*S*,23*E*)-20,25-Dihydroxy-3,4-secodammara-4(28),23-dienoic acid methyl ester [**2.22**] :R = CH_3

Figure 4. Chemical structures of dammarane – type triterpenoids in the Meliaceae (continued)

Aromadendrane – type sesquiterpenes

Aromadendranes are a class of sesquiterpene natural products found in a number of plant species (Gijsen *et al.*, 1992), especially in species belonging to Compositae, Leguminosae, and Myrtaceae. They are also found in marine organisms including soft corals, sponges, and liverwort (Staerk *et al.*, 2004). Aromadendranes are tricyclic sesquiterpenes structurally characterized by a dimethyl cyclopropane unit fused to a hydroazulene ring system (Stephen *et al.*, 1996).

Distribution of aromadendrane – type sesquiterpenes in plants is summarized in **Table 4** and their chemical structures are shown in **Figure 5.**

Table 4. Distribution of aromadendrane – type sesquiterpenes in plants.

Compound	Sources	Family	Part	References
2′-Acetyl arvoside B **[3.1]**	*Calendula arvensis*	Compositae	Aerial parts	Pizza *et al.*, 1988
Alloaromadendran-14β-al **[3.2]**	*Duguetia glabriuscula*	Annonaceae	Leaves	De Siqueira *et al.*, 2003
Alloaromadendran-14β-oic acid **[3.3]**	*Duguetia glabriuscula*	Annonaceae	Leaves	De siqueira *et al.*, 2003
(+)-Aromadendra-1(10),4-dien-15-al-3-one **[3.4]**	*Mandevilla pentlandiana*	Apocynaceae	Root	Cabrera *et al.*,1993
1(5),3-Aromadendradiene **[3.5]**	*Balsamum tolutanum*	Leguminosae	n.i.	Friedel *et al.*, 1987
1(10),4-Aromadendradiene **[3.6]**	*Balsamum tolutanum*	Leguminosae	n.i.	Friedel *et al.*, 1987
(+)-Alloaromadendrane-4β,10α-diol **[3.7]**	*Ambrosia peruviana*	Compositae	Stem, leaves	Goldsby and Burke, 1987
	Phebalium filifolium	Rutaceae	Aerial parts	Rashid *et al.*, 1995
(+)-Alloaromadendran-10,14β-diol **[3.8]** (14-hydroxyviridiflorol)	*Duguetia glabriuscula*	Annonaceae	Leaves	Matos *et al.*, 2006
	Pulicaria paludosa	Compositae	Aerial parts	Feliciano *et al.*, 1989

Table 4. Distribution of aromadendrane – type sesquiterpenes in plants. (continued)

Compound	Sources	Family	Part	References
Alloaromadendrene **[3.9]**	*Duguetia glabriuscula*	Annonaceae	Leaves	De Siqueira *et al.*, 2003
Alloaromadendrane-4β,10α-diol **[3.10]**	*Xylopia brasiliensis*	Annonaceae	Leaves	Moreira *et al.*, 2003
Aromadendrane-4α,10α-diol **[3.11]**	*X. brasiliensis*	Annonaceae	Leaves	Moreira *et al.*, 2003
Aromadendrane-4α,10β-diol **[3.12]**	*X. brasiliensis*	Annonaceae	Leaves	Moreira *et al.*, 2003
Aromadendrane-4β,10α-14-triol **[3.13]**	*X. brasiliensis*	Annonaceae	Leaves	Moreira *et al.*, 2003
Aromadendrane-4β,10α-diol **[3.14]**	*Brasilia sickii*	Compositae	Root	Bohlmann *et al.*, 1983
	Aglaia grandis	Meliaceae	Leaves	Inada *et al.*, 2000
Aromadendrane-4β,10β-diol **[3.15]**	*Ambrosia peruviana*	Compositae	Stem, leaves	Goldsby and Burke, 1987
	Aristolochia heterophylla	Aristolochiaceae	Root, Stem	Wu, Chan and Leu, 2000
(+)-Aromadendrene **[3.16]**	*Eucalyptus globulus*	Myrtaceae	Leaves	Graham *et al.*, 1960
Arvoside B **[3.17]**	*Calendula arvensis*	Compositae	Aerial parts	Pizza *et al.*, 1988
Cyclocolorenone **[3.18]**	*Drimys brasiliensis*	Winteraceae	Stem bark, Leaves, Fruits	Limberger *et al.*, 2007
Dendroside A **[3.19]**	*Dendrobium nobile*	Orchidaceae	Stem	Zhao *et al* ., 2001
Dendroside D **[3.20]**	*D. nobile*	Orchidaceae	Stem	Ye *et al* ., 2002

Table 4. Distribution of aromadendrane – type sesquiterpenes in plants. (continued)

Compound	Sources	Family	Part	References
12,13-Diacetoxy-2-oxo-aromadendr-1(10)-ene **[3.21]**	*Gnephosis arachnoidea*	Compositae	Aerial parts	Jakupovic *et al.*, 1988
(2*S*,4*R*,5*S*,6*R*,7*R*,9*S*)-2,9-Dihydroxy-1(10)-aromadendren-14-oic acid 2,14-lactone **[3.22]**	*Landolphia dulcis*	Apocynaceae	Root	Staerk *et al.*, 2004
(2*S*,4*R*,5*S*,6*R*,7*R*,11*S*)-2,12-Dihydroxy-1(10)-aromadendren-14-oic acid 2,14-lactone **[3.23]**	*L. dulcis*	Apocynaceae	Root	Staerk *et al.*, 2004
8α,13-Dihydroxy spathulenol **[3.24]**	*Cineraria fruticulorum*	Compositae	Aerial parts	Bohlmann *et al.*, 1982
Epiglobulol **[3.25]**	*Eucalyptus globulus*	Myrtaceae	Leaves	Graham *et al.*, 1960
Flourensadiol **[3.26]**	*Flourensia cernua*	Compositae	Whole plant	Kingston *et al.*, 1975
(+)-Globulol **[3.27]**	*Angelica sylvestris*	Apiaceae	Root	Vinokurova *et al.*, 1999
(-)-Globulol **[3.28]**	*Eucalyptus globulus*	Myrtaceae	Leaves	Graham *et al.*, 1960
(-)-α-Gurjunene **[3.29]**	*Lansium anamalayanum*	Meliaceae	Wood	Krishnappa and Dev, 1973
(1*R*,6*R*,7*R*,10*R*,11*S*)-12-Hydroxy-4(5)-aroma-dendren-3-one **[3.30]**	*Landolphia dulcis*	Apocynaceae	Root	Staerk *et al.*, 2004

Table 4. Distribution of aromadendrane – type sesquiterpenes in plants. (continued)

Compound	Sources	Family	Part	References
(4*R*,5*S*,6*R*,7*R*,11*S*)-12-Hydroxy-1(10)-aromadendren-14-al **[3.31]**	*L. dulcis*	Apocynaceae	Root	Staerk *et al.*, 2004
(4*R*,5*S*,6*R*,7*R*,11*S*)-12-Hydroxy-1(10)-aromadendren-2-one **[3.32]**	*L. dulcis*	Apocynaceae	Root	Staerk *et al.*, 2004
(4*R*,5*S*,6*R*,7*R*,11*S*)-12-Hydroxy-1(10)-aromadendren-9-one **[3.33]**	*L. dulcis*	Apocynaceae	Root	Staerk *et al.*, 2004
(2*S*,4*R*,5*S*,6*R*,7*R*)-2-Hydroxy-1(10)-aromadendren-14-oic acid 2,14-lactone **[3.34]**	*L. dulcis*	Apocynaceae	Root	Staerk *et al.*, 2004
8α-Hydroxy-13-oxo-spathulenol **[3.35]**	*Cineraria fruticulorum*	Compositae	Aerial parts	Bohlmann *et al.*, 1982
8α-Hydroxy spathulenol **[3.36]**	*C. fruticulorum*	Compositae	Aerial parts	Bohlmann *et al.*, 1982
(+)-13-Hydroxy spathulenol **[3.37]**	*Eriostemon brucei*	Rutaceae	Aerial parts	Rashid *et al.*, 1995
(+)-Ledol **[3.38]**	*Entandrophragma cylindricum*	Meliaceae	Bark	Daniewski *et al.*, 1996
(-)-Ledol **[3.39]**	*Duguetia glabriuscula*	Annonaceae	Leaves	De Siqueira *et al.*, 2003

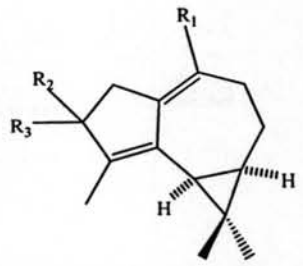
Table 4. Distribution of aromadendrane – type sesquiterpenes in plants. (continued)

Compound	Sources	Family	Part	References
(-)-Ledol [**3.39**]	*Phebalium tuberculosum*	Rutaceae	Aerial parts	Rashid *et al.*, 1995
	Piper clusii	Piperaceae	Fruits	Koul *et al.*, 1993
2′(2′′-Methyl-butanoyl) arvoside B [**3.40**]	*Calendula arvensis*	Compositae	Aerial parts	Pizza *et al.*, 1988
2′(2′′-Methyl-2′′-butenoyl) arvoside B [**3.41**]	*C. arvensis*	Compositae	Aerial parts	De Tom masi *et al.*, 1990
Methyl (4*R*,5*S*,6*R*,7*R*,11*S*)-2,9-dioxo-1(10)-aromadendren-12-oate [**3.42**]	*Landolphia dulcis*	Apocynaceae	Root	Staerk *et al.*, 2004
2′(3′′-Methyl-2′′-pentenoyl) arvoside B [**3.43**]	*Calendula arvensis*	Compositae	Aerial parts	Pizza *et al.*, 1988
2′(2′′-Methyl-2′′-propanoyl) arvoside B [**3.44**]	*C. arvensis*	Compositae	Aerial parts	De Tom masi *et al.*, 1990
(4*R*,5*S*,6*R*,7*R*,11*S*)-2-Oxo-1(10)-aromadendren-12-oic acid [**3.45**]	*Landolphia dulcis*	Apocynaceae	Root	Staerk *et al.*, 2004
(+)-Spathulenol [**3.46**]	*Duguetia glabriuscula*	Annonaceae	Leaves	De Siqueira *et al.*, 2003
	Guarea guidonia	Meliaceae	Leaves	Brochini and Roque, 2000

Table 4. Distribution of aromadendrane – type sesquiterpenes in plants. (continued)

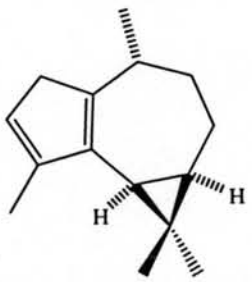
Compound	Sources	Family	Part	References
(+)-Spathulenol [**3.46**]	*Drummondita basselli*	Rutaceae	Aerial parts	Rashid *et al.*, 1995
	D. calida	Rutaceae	Aerial parts	Rashid *et al.*, 1995
	Phebalium tuberculosum	Rutaceae	Aerial parts	Rashid *et al.*, 1995
	P. filifolium	Rutaceae	Aerial parts	Rashid *et al.*, 1995
	Xylopia brasiliensis	Annonaceae	Leaves	Moreira *et al.*, 2003
β-Spathulene [**3.47**]	*Schinus molle*	Anacardiaceae	Fruits	Terhune, Hogg and Lawrence, 1974
Squamulosone [**3.48**]	*Hyptis verticillata*	Labiatae	n.i.	Collins *et al.*, 2001
	Phebalium squamulosum	Rutaceae	n.i.	Batey, Hellyer and Pinhey, 1971
(-)-10*β*,13,14-Trihydroxy-*allo*-aromadendrane [**3.49**]	*Wyethia arizonica*	Compositae	n.i.	Bohlmann *et al.*, 1984
Viridiflorol [**3.50**]	*Duguetia glabriuscula*	Annonaceae	Leaves	De Siqueira *et al.*, 2003

n.i. = not indicated

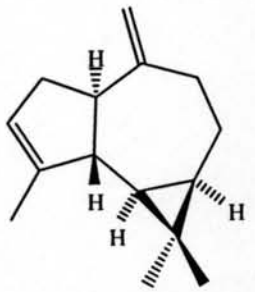


(+)-Aromadendra-1(10),4-dien-15-al-3-one [**3.4**] :R_1 = CHO, R_2, R_3= O

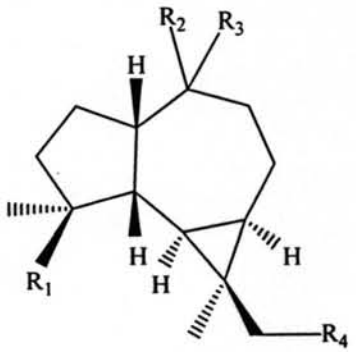
1(10),4-Aromadendradiene [**3.6**] :R_1 = CHO, R_2, R_3= O



1(5),3-Aromadendradiene [**3.5**]

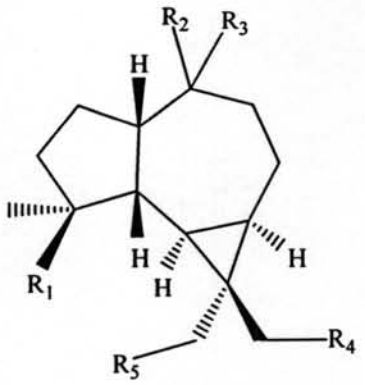


β-Spathulene [**3.47**]

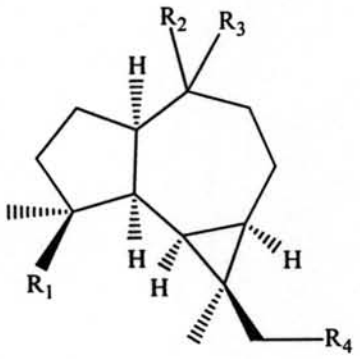


	R_1	R_2	R_3	R_4
Alloaromadendran-14*β*-al [**3.2**]	H	*β*-CHO	*α*-CH_3	H
Alloaromadendran-14*β*-oic acid [**3.3**]	H	*β*-COOH	*α*-H	H
(+)-Alloaromadendran-10,14*β*-diol (14-hydroxyviridiflorol) [**3.8**]	H	*α*- CH_2OH	*β*-OH	H
Flourensadiol [**3.26**]	H	*β*-OH	*α*-CH_3	OH
(-)-Ledol [**3.39**]	H	*α*-OH	*β*-CH_3	H
Viridiflorol [**3.50**]	H	*β*-OH	*α*-CH_3	H

Figure 5. Chemical structures of aromadendrane – type sesquiterpenes in plants

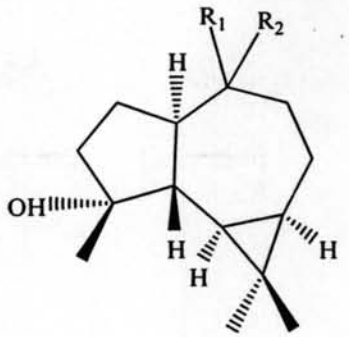


	R_1	R_2	R_3	R_4	R_5
Alloaromadendrane-4β,10α-diol **[3.10]**	OH	α-OH	β-CH_3	CH_3	H
Dendroside A[**3.19**]	H	α-CH_2Oglu	β-OH	CH_2OH	H
Dendroside D[**3.20**]	H	α-CH_2Oglu	β-OH	COOglu	H
(-)-10β,13,14-Trihydroxy-*allo*-aromadendrane [**3.49**]	H	β-OH	α-CH_2OH	CH_3	OH

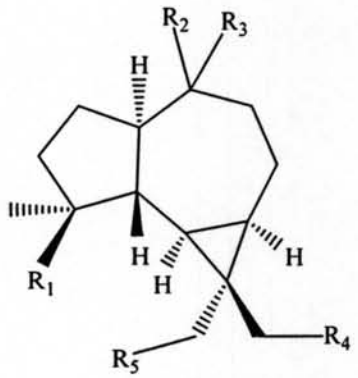


	R_1	R_2	R_3	R_4
(+)-Alloaromadendrane- 4β,10α-diol [**3.7**]	OH	α-OH	β-CH_3	H
(+)-Globulol [**3.27**]	H	α-OH	β-CH_3	H
(+)-Ledol [**3.38**]	H	β-OH	α-CH_3	H

Figure 5. Chemical structures of aromadendrane – type sesquiterpenes in plants (continued)

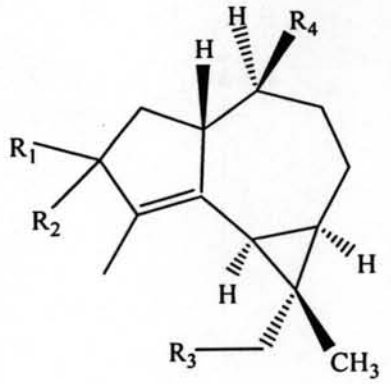


	R_1	R_2
Aromadendrane-4α,10α-diol **[3.11]**	α-OH	β-CH_3
Aromadendrane-4α,10β-diol **[3.12]**	β-OH	β-CH_3

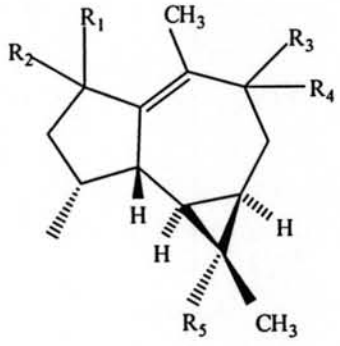


	R_1	R_2	R_3	R_4	R_5
Aromadendrane-4β,10α-14-triol **[3.13]**	OH	β-CH_2OH	α-OH	CH_3	H
Aromadendrane-4β,10α-diol **[3.14]**	OH	α-OH	β-CH_3	CH_3	H
Aromadendrane-4β,10β-diol **[3.15]**	OH	β-OH	α-CH_3	CH_3	H
Epiglobulol **[3.25]**	H	β-OH	α-CH_3	CH_3	H
(-)-Globulol **[3.28]**	H	β-OH	α-CH_3	CH_3	H

Figure 5. Chemical structures of aromadendrane – type sesquiterpenes in plants (continued)

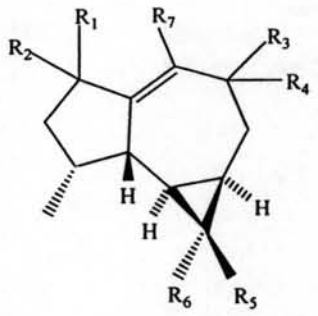


	R_1	R_2	R_3
Cyclocolorenone **[3.18]**		=O	H
(-)-α-Gurjunene **[3.29]**	H	H	H
(1*R*,6*R*,7*R*,10*R*,11*S*)-12-Hydroxy-4(5)-aromadendren-3-one **[3.30]**		=O	OH

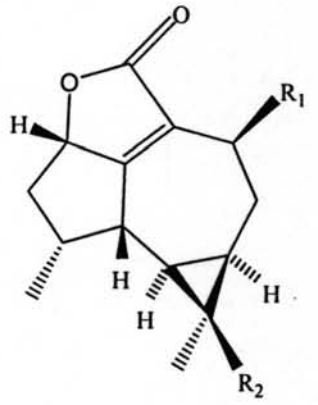


	R_1	R_2	R_3	R_4	R_5
(4*R*,5*S*,6*R*,7*R*,11*S*)-12-Hydroxy-1(10)-aromadendren-2-one **[3.32]**	=O		H	H	CH_2OH
(4*R*,5*S*,6*R*,7*R*,11*S*)-12-Hydroxy-1(10)-aromadendren-9-one **[3.33]**	H	H	=O		CH_2OH
Squamulosone **[3.48]**	H	H	=O		CH_3
(4*R*,5*S*,6*R*,7*R*,11*S*)-2-Oxo-1(10)-aromadendren-12-oic acid **[3.45]**	=O		H	H	COOH

Figure 5. Chemical structures of aromadendrane – type sesquiterpenes in plants (continued)



	R_1	R_2	R_3	R_4	R_5	R_6	R_7
12,13-Diacetoxy-2-oxo-aromadendr-1(10)-ene [**3.21**]	=O		H	H	CH_2OAc	CH_2OAc	CH_3
(4*R*,5*S*,6*R*,7*R*,11*S*)-12-Hydroxy-1(10)-aromadendren-14-al [**3.31**]	H	H	H	H	CH_3	CH_2OH	CHO
Methyl (4*R*,5*S*,6*R*,7*R*,11*S*)-2,9-dioxo-1(10)-aromadendren-12-oate [**3.42**]	=O		=O		CH_3	$COOCH_3$	CH_3

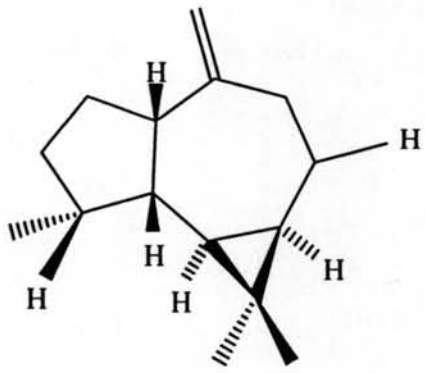


(2*S*,4*R*,5*S*,6*R*,7*R*)-2-Hydroxy-1(10)-aromadendren-14-oic acid 2,14-lactone [**3.34**] :R_1 = H, R_2 =CH_3

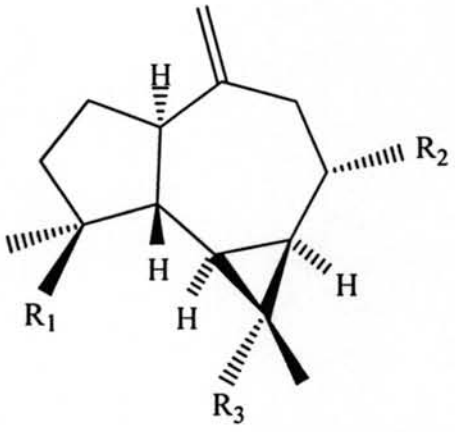
(2*S*,4*R*,5*S*,6*R*,7*R*,9*S*)-2,9-Dihydroxy-1(10)-aromadendren-14-oic acid 2,14-lactone [**3.22**] :R_1 = OH, R_2 =CH_3

(2*S*,4*R*,5*S*,6*R*,7*R*,11*S*)-2,12-Dihydroxy-1(10)-aromadendren-14-oic acid 2,14-lactone [**3.23**] :R_1 = H, R_2 =CH_2

Figure 5. Chemical structures of aromadendrane – type sesquiterpenes in plants (continued)



Alloaromadendrene [**3.9**]



(+)-Spathulenol [**3.46**] :R_1 = OH, R_2 = H, R_3 = CH_3

(+)-Aromadendrene [**3.16**] :R_1 = H, R_2 = H, R_3 = CH_3

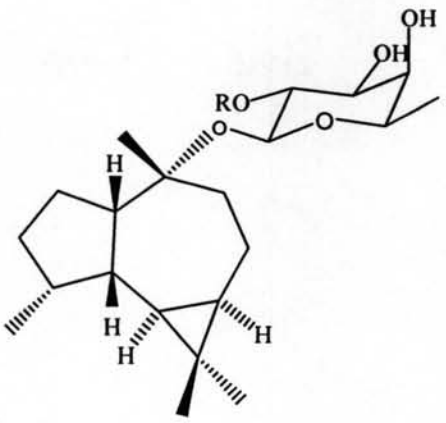
(+)-13-Hydroxyspathulenol [**3.37**] :R_1 = OH, R_2 = H, R_3 = CH_2OH

8α -Hydroxyspathulenol [**3.36**] :R_1 = OH, R_2 = OH, R_3 = CH_3

8α,13-Dihydroxyspathulenol [**3.24**] :R_1 = OH, R_2 = OH, R_3 = CH_2OH

8α-Hydroxy-13-oxo-spathulenol [**3.35**] :R_1 = OH, R_2 = OH, R_3 = CHO

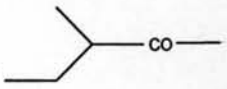
Figure 5. Chemical structures of aromadendrane – type sesquiterpenes in plants (continued)



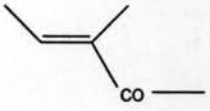
2′-Acetyl arvoside B **[3.1]** :R = Ac

Arvoside B **[3.17]** :R = H

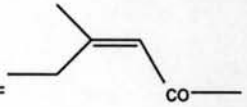
2′(2′′-Methyl-butanoyl) arvoside B **[3.40]** :R =



2′(2′′-Methyl-2′′-butenoyl) arvoside B **[3.41]** :R =



2′(3′′-Methyl-2′′-pentenoyl) arvoside B **[3.43]** :R =



2′(2′′-Methyl-2′′-propanoyl) arvoside B **[3.44]** :R =

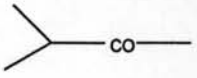


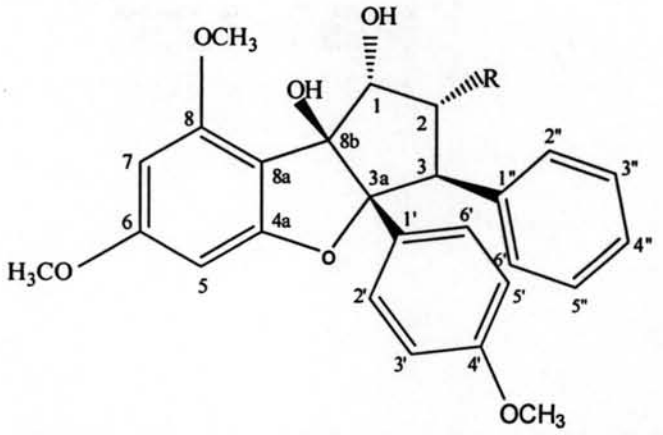
Figure 5. Chemical structures of aromadendrane – type sesquiterpenes in plants (continued)

Aromadendrane-type sesquiterpenes displayed various biological activities. For example dendroside A from the stems of *Dendrobium nobile* (family Orchidaceae), a plant used as tonic in traditional Chinese medicine, significantly stimulated the proliferation of murine T and B lymphocytes *in vitro* at concentrations of 1×10^{-7} and 1×10^{-5} M, respectively (Zhao *et al.*, 2001). Another compound, (+)-alloaromadendran-10,14β-diol (14-hydroxyviridiflorol) from *Duguetia glabriuscula* (family Annonaceae), showed cytotoxic activity by inhibiting the growth of Hep_2 (human larynx carcinoma) cell line ($IC_{50} < 25$ µg/ml) (Matos *et al.*, 2006).

Cladosporium herbarium and *C. cladosporioides* are important causes of mould allergies in human. It was found that (+)-alloaromadendrane-4β,10α-diol, an aromadendrane sesquiterpene from the stems and leaves of *Ambrosia peruviana* (family Compositae), together with aromadendrane-4α,10β-diol and aromadendrane-4α,10α-diol from the leaves of *Xylopia brasiliensis* (family Annonaceae), exhibited antifungal activity against these allergic molds. (Goldsby and Buke, 1987; Moreira *et al.*, 2003). Arvoside B, an aromadendrane glycoside from the aerial parts of *Calendula arvensis* (family Compositae), showed *in vitro* antiviral activity against vesicular stomatitis virus at MIC of 14 µg/ml (De Tommasi *et al.*, 1990). Squamulosone, isolated in large quantity from *Hyptis verticillata* (family Labiatae), a medicinal plant which has been traditionally used in the treatment of eczema, psoriasis, scabies, athlete's foot, rheumatoid arthritis and cold-related problems, displayed insecticidal activity against the sweet potato weevil, *Cylas formicarius elegantulus* (Collins *et al.*, 2001).

Flavagline derivatives

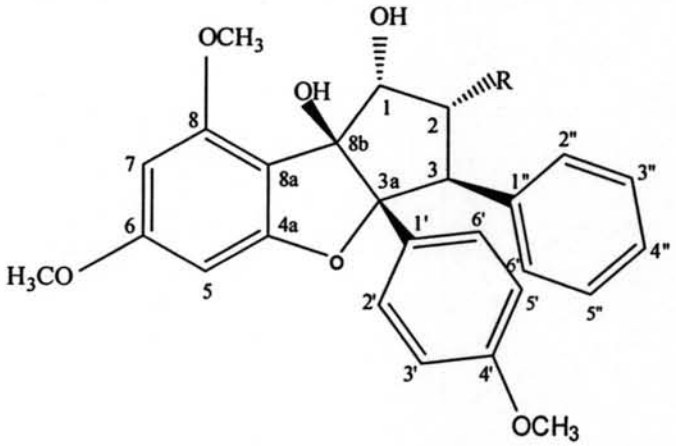
Flavagline derivatives are unusual benzofuran derivatives featuring a cyclopenta[*b*]benzofuran skeleton.



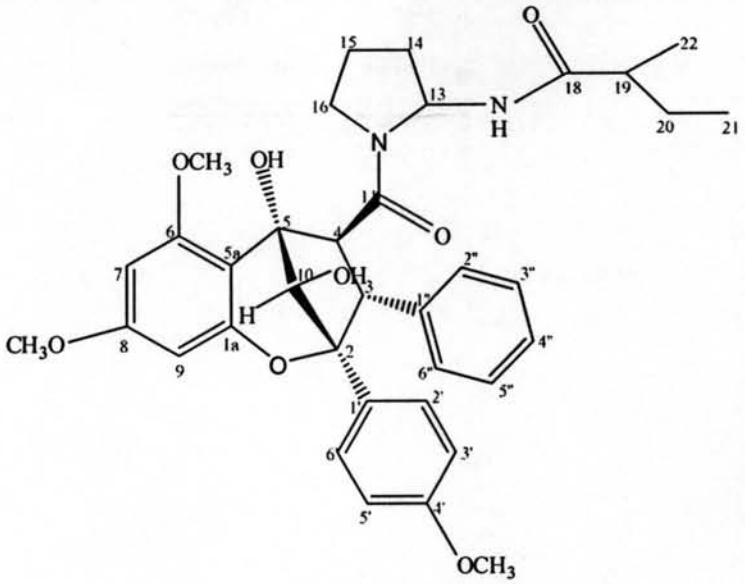
They were initially named rocaglamide derivatives after the parent compound rocaglamide, originally isolated in 1982 (King *et al.*, 1982). These compounds appear to be derived from a flavonoid nucleus linked with a cinnamic acid moiety (Nugroho *et al.*, 1999). The incorporation of nitrogen into rocaglamide represents a late biosynthetic step, therefore, the general use of the term rocaglamides for all derivatives of that basic structure can not be applied to every compound within this group. Regarding the restricted occurrence of this type of compounds to the genus *Aglaia* of the family Meliaceae and the incorporation of a flavonoid moiety as a central biosynthetic step, the name flavaglines was therefore suggested for this class of compounds (Brader *et al.*, 1998).

Flavaglines can be classified into three groups (Proksch *et al.*, 2001) :

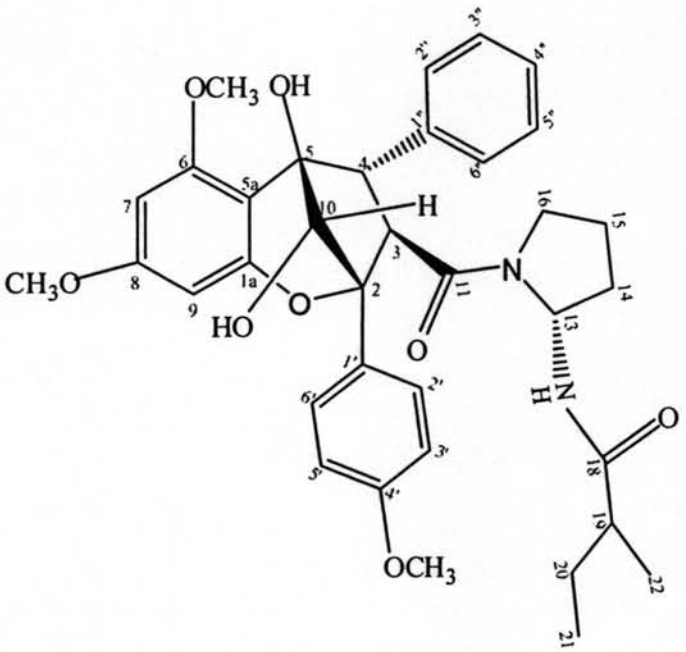
1) Cyclopenta[*b*]benzofuran derivatives (rocaglamide derivatives)



2) Cyclopenta[*bc*] benzopyran derivatives (aglain and aglaforbesin derivatives)

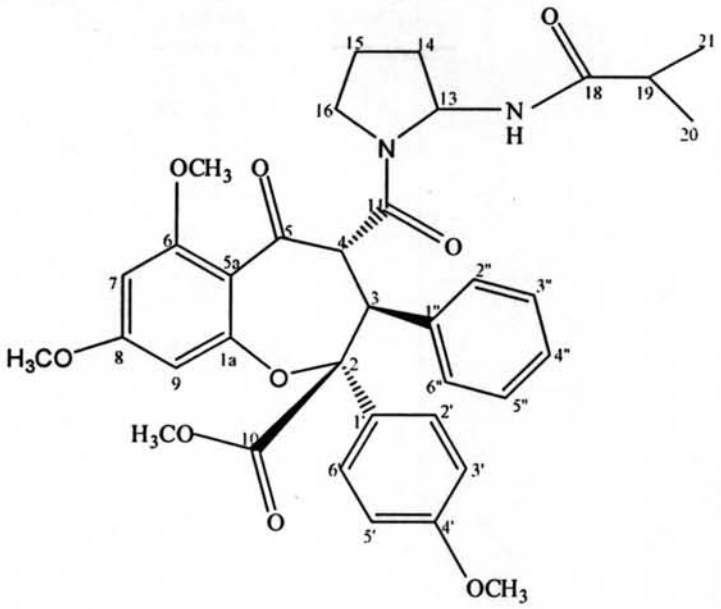


aglain derivatives



aglaforbesin derivatives

3) Benzo[*b*]oxe-pine derivatives (forbagline derivatives)



Many members of the cyclpenta[*b*]benzofuran groups exhibited biological activities such as insecticidal activity (Ishibashi *et al.*, 1993; Janprasert *et al.*, 1993; Nugroho *et al.*, 1997a, 1997b; Brader *et al.*, 1998; Bacher *et al*, 1999; Chaidir *et al.*, 1999; Hiort *et al.*, 1999; Nugroho *et al.*, 1999; Schneider *et al.*, 2000; Dreyer *et al.*, 2001; Greger *et al.*, 2001; Bringmann *et al.*, 2003) comparable in potency to azadirachtin the well-known natural insecticide from the neem tree, *Azadirachta indica* L. These flavaglines also displayed significant inhibitory activity against cancer cell lines at nanomolar concentrations (King *et al.*, 1982; Dumontet *et al.*, 1996; Cui *et al.*, 1997; Lee *et al.*, 1998; Mohamad *et al.*, 1999; Proksch *et al.*, 2001; Baumann *et al.*, 2002; Hausott *et al.*, 2004; Hwang, *et al.*, 2004; Rivero-Cruz, *et al.*, 2004; Chumkaew *et al.*, 2006; Kim *et al.*, 2006; Su *et al.*, 2006; Salim, *et al.*, 2007). However, the cyclopenta[*bc*]benzopyrans and benzo[*b*]oxepines evaluated so far were not active (Kim *et al.*, 2006).

The distribution of flavagline derivatives in the family Meliaceae is summarized in **Table 5** and their chemical structures are shown in **Figure 6.**

Table 5. Distribution of flavagline compounds in the family Meliaceae.

Compounds	Source	part	References
Cyclopenta[*b*]benzofurans 1-*O*-Acetyl-N-butanoyl-didesmethylrocaglamide **[4.1]**	*Aglaia elliptica*	Fruits	Nugroho *et al.*, 1997b
1-*O*-Acetyldemethyl-rocaglamide **[4.2]**	*A. duperreana*	Flowers	Chaidir *et al.*, 1999
		Root	Hiort *et al.*, 1999
1-*O*-Acetyl-4'-demethoxy-3',4'-methylenedioxy-methyl rocaglate **[4.3]**	*A. spectabilis*	Bark	Schneider *et al.*, 2000
1-*O*-Acetyl-didemethyl-rocaglamide **[4.4]**	*A. duperreana*	Flowers	Chaidir *et al.*, 1999
1-*O*-Acetyl-3'-hydroxydemethylrocaglamide **[4.5]**	*A. duperreana*	Flowers	Chaidir *et al.*, 1999
		Root	Hiort *et al.*, 1999
1-*O*-Acetyl-3'-hydroxy methylrocaglate **[4.6]**	*A. duperreana*	Flowers	Chaidir *et al.*, 1999
		Root	Hiort *et al.*, 1999
1-*O*-Acetyl-3'-hydroxy-rocaglamide **[4.7]**	*A. duperreana*	Flowers	Chaidir *et al.*, 1999
		Twigs	Nugroho *et al.*, 1997a
		Root	Hiort *et al.*, 1999
	A. odorata	Twigs	Nugroho *et al.*, 1999
		Leaves	Ishibashi *et al.*, 1993
1-*O*-Acetyl-rocaglamide **[4.8]**	*A. duperreana*	Root	Hiort *et al.*, 1999
1-*O*-Acetylmethyl rocaglate **[4.9]**	*A. duperreana*	Root	Hiort *et al.*, 1999
		Flowers	Chaidir *et al.*, 1999
	A. rubiginosa	Twigs	Rivero-Cruz *et al.*, 2004
1-*O*-Acetylrocaglaol **[4.10]**	*A .rubiginosa*	Twigs	Rivero-Cruz *et al.*, 2004
Aglaiastatin **[4.11]** (aglaroxin D)	*A. duperreana*	Twigs	Nugroho *et al.*, 1997a

Table 5. Distribution of flavagline compounds in the family Meliaceae. (continued)

Compounds	Source	part	References
Aglaiastatin [**4.11**] (aglaroxin D)	*A. odorata*	Leaves	Ohse *et al.*, 1996
N-Butanoyl-didesmethylrocaglamide [**4.12**]	*A. elliptica*	Fruits	Nugroho *et al.*, 1997b
Cyclorocaglamide (6-demethoxy-8b,2'-epoxy-3'-methoxy-6,7-methylenedioxy rocaglamide) [**4.13**]	*A. oligophylla*	Twigs	Bringmann *et al.*, 2003
Dehydroaglaiastatin [**4.14**]	*A. duperreana*	Twigs	Nugroho *et al.*, 1997a
		Flowers	Chaidir *et al.*, 1999
		Root	Hiort *et al.*, 1999
	A. odorata	Root	Kokpol *et al.*, 1994
		Leaves	Ohse *et al.*, 1996
		Root	Kokpol *et al.*, 1994
	A. testicularis	Leaves	Wang et al., 2004
6-Demethoxy-2'-hydroxy-3'-methoxy-6,7-methylenedioxy rocaglamide [**4.15**]	*A. oligophylla*	Twigs	Bringmann *et al.*, 2003
4'-Demethoxy-3', 4'-methylenedioxy-methyl rocaglate [**4.16**]	*A. dasyclada*	Leaves	Chaidir *et al.*, 2001
	A. elliptica	Stem, Fruits	Cui *et al.*, 1997
		Stems	Lee *et al.*, 1998
	A. spectabilis	Bark	Schneider *et al.*, 2000
6-Demethoxy-6,7-methylenedioxymethyl-rocaglate [**4.17**] (Pannellin)	*A.elaeagnoidea*	Leaves, Stems, Root , Bark	Brader *et al.*, 1998

Table 5. Distribution of flavagline compounds in the family Meliaceae. (continued)

Compounds	Source	part	References
6-Demethoxy-6,7-methylenedioxymethyl-rocaglate [**4.17**] (Pannellin)	*A. oligophylla*	Twigs	Dreyer *et al.*, 2001
6-Demethoxy-6,7-methylenedioxy rocaglamide (aglaroxin A) [**4.18**]	*A.elaeagnoidea*	Stem bark	Molleyres *et al.*, 1999
	A. oligophylla	Twigs	Dreyer *et al.*, 2001
4'-Demethoxy-3',4'-methylenedioxyrocaglaol [**4.19**]	*A. elliptica*	Fruits	Cui *et al.*, 1997
	A. spectabilis	Bark	Schneider *et al.*, 2000
1-Oxo-4'-demethoxy-3',4'-methylenedioxy rocaglaol [**4.20**]	*A. elliptica*	Stem	Cui *et al.*, 1997
Desmethylrocaglamide [**4.21**]	*A. duperreana*	Flowers	Chaidir *et al.*, 1999
	A. odorata	Leaves	Ishibashi *et al.*, 1993
Didesmethylrocaglamide [**4.22**]	*A. argentea*	Seeds	Dumontet *et al.*, 1996
	A. duperreana	Root	Hiort *et al.*, 1999
	A. elliptica	Fruits	Nugroho *et al.*, 1997b
Episilvestrol [**4.23**]	*A. pyramidata*	Twigs	Hwang *et al.*, 2004
8b-*O*-Ethyl-demethylrocaglamide [**4.24**]	*A. duperreana*	Flowers	Chaidir *et al.*, 1999
8b-*O*-Ethyl-3'-hydroxyrocaglamide [**4.25**]	*A. duperreana*	Flowers	Chaidir *et al.*, 1999
Ethylrocaglaol [**4.26**]	*A. forbesii*	Bark	Dumontet *et al.*, 1996
1-*O*-Formylmethyl rocaglate [**4.27**]	*A. dasyclada*	Leaves	Chaidir *et al.*, 2001
	A. spectabilis	Bark	Schneider *et al.*, 2000

Table 5. Distribution of flavagline compounds in the family Meliaceae. (continued)

Compounds	Source	part	References
1-*O*-Formyloxy-4'-demethoxy-3',4'-methylenedioxy-methyl rocaglate **[4.28]**	*A. elliptica*	Stem	Cui *et al.*, 1997 Lee *et al.*, 1998
	A. spectabilis	Bark	Schneider *et al.*, 2000
1-*O*-Formylrocagloic acid **[4.29]**	*Amoora cucullata*	Fruits	Chumkaew *et al.*, 2006
3'-Hydroxy-dehydroaglaiastatin **[4.30]**	*A. duperreana*	Flowers	Chaidir *et al.*, 1999
	A. testicularis	Leaves	Wang et al., 2004
3'-Hydroxydemethyl-rocaglamide **[4.31]**	*A. odorata*	Leaves	Nugroho *et al.*, 1999
	A. duperreana	Root	Ohse *et al.*, 1996
3'-Hydroxy-1-*O*-formyloxy-methyl rocaglate **[4.32]**	*A. spectabilis*	Bark	Schneider *et al.*, 2000
3'-Hydroxydidemethyl-rocaglamide **[4.33]**	*A. odorata*	Leaves	Nugroho *et al.*, 1999
3'-Hydroxymarikarin **[4.34]**	*A. gracilis*	Root and Stem bark	Greger *et al.*, 2001
3'-Hydroxymethyl rocaglate **[4.35]**	*A. duperreana*	Root	Ohse *et al.*, 1996
	A. odorata	Leaves	Nugroho *et al.*, 1999
	A. spectabilis	Bark	Schneider *et al.*, 2000
	Amoora cucullata	Fruits	Chumkaew *et al.*, 2006
3'-Hydroxyrocaglamide **[4.36]**	*A. duperreana*	Flowers	Chaidir *et al.*, 1999
		Twigs	Nugroho *et al.*, 1997a
		Root	Hiort *et al.*, 1999
	A. odorata	Twigs and Leaves	Nugroho *et al.*, 1999
3'-Hydroxyrocagloic acid **[4.37]**	*Amoora cucullata*	Fruits	Chumkaew *et al.*, 2006

Table 5. Distribution of flavagline compounds in the family Meliaceae. (continued)

Compounds	Source	part	References
Marikarin [**4.38**]	*A. gracilis*	Root, Stem bark	Greger *et al.*, 2001
3'-Methoxy-6-demethoxy-6,7-methylenedioxy rocaglamide [**4.39**]	*A.elaeagnoidea*	Stem bark	Molleyres *et al.*, 1999
	A. oligophylla	Twigs	Dreyer *et al.*, 2001
3'- Methoxy-methyl rocaglate [**4.40**]	*A. spectabilis*	Bark	Schneider *et al.*, 2000
3'-Methoxypannellin [**4.41**]	*A. elaeagnoidea*	Leaves, Stems, Root, Bark	Brader *et al.*, 1998
3'- Methoxylrocaglaol [**4.42**]	*A. odorata*	Twigs	Nugroho *et al.*, 1999
		Leaves	Nugroho *et al.*, 1999
3'- Methoxyrocaglamide [**4.43**]	*A. duperreana*	Twigs	Nugroho *et al.*, 1997a
	A. odorata	Twigs	Nugroho *et al.*, 1999
8b-*O*-methyl-methyl rocaglate [**4.44**]	*A. duperreana*	Root	Hiort *et al.*, 1999
Methyl rocaglate [**4.45**] (Aglafoline)	*A. dasyclada*	Leaves	Chaidir *et al.*, 2001
	A. duperreana	Flowers	Chaidir *et al.*, 1999
		Root	Hiort *et al.*, 1999
	A.elaeagnoidea	Bark	Fuzzati *et al.*, 1996
	A. elliptica	Stem and Fruits	Cui *et al.*, 1997
	A. odorata	Leaves	Ishibashi *et al.*, 1993
	A. rubiginosa	Twigs	Rivero-Cruz *et al.*, 2004
	A. spectabilis	Bark	Schneider *et al.*, 2000
	Amoora cucullata	Fruits	Chumkaew *et al.*, 2006

Table 5. Distribution of flavagline compounds in the family Meliaceae. (continued)

Compounds	Source	part	References
Methyl rocaglate [**4.45**] (Aglafoline)	*A. elliptifolia*	n.i.	Ko *et al.*, 1992
	A. ponapensis	Leaves and twigs	Salim *et al.*, 2007
8b-*O*-methylrocaglaol [**4.46**]	*A. duperreana*	Root	Hiort *et al.*, 1999
1-Oxime-3'-methoxy-methylrocaglate [**4.47**]	*A. odorata*	Leaves	Nugroho *et al.*, 1999
1-Oxo-2-piriferine-6-demethoxy-6,7-methylenedioxy rocaglamide [**4.48**]	*A. oligophylla*	Twigs	Dreyer *et al.*, 2001
	A. spectabilis	Bark	Schneider *et al.*, 2000
Pannellin 1-*O*-acetate [**4.49**]	*A. elaeagnoidea*	Leaves, Stems and Root, Bark	Brader *et al.*, 1998
Rocaglamide [**4.50**]	*A. duperreana*	Twigs	Nugroho *et al.*, 1997a
		Root	Hiort *et al.*, 1999
	A. elliptica	Fruits	Nugroho *et al.*, 1997b
	A. elliptifolia	Root and Stem	King *et al.*, 1982
	A. odorata	Twigs	Janprasert *et al.*, 1993
		Leaves	Ishibashi *et al.*, 1993
Rocaglaol-3'-rhamnose [**4.51**]	*A. harmsiana*	Leaves	Nugroho *et al.*, 1997b
Rocaglaol [**4.52**]	*A. duperreana*	Root	Hiort *et al.*, 1999
	A. elliptifolia	Stem	Cui *et al.*, 1997
	A. odorata	Leaves	Ishibashi *et al.*, 1993
			Ohse *et al.*, 1996

Table 5. Distribution of flavagline compounds in the family Meliaceae. (continued)

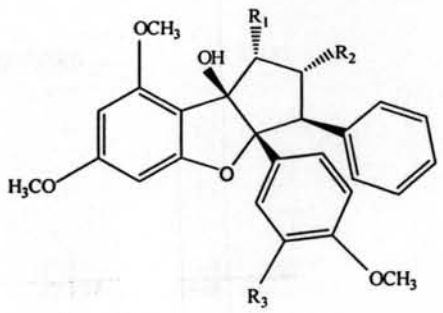
Compounds	Source	part	References
Rocaglaol [**4.52**]	*A. crassinervia*	Bark	Su *et al.*, 2006
	A. dasyclada	Leaves	Chaidir *et al.*, 2001
	A. ferruginaea	n.i.	Mulholland and Naidoo, 1998
	A. forbesii	Bark	Dumontet *et al.*, 1996
	A. spectabilis	Bark	Schneider *et al.*, 2000
	A. tomentosa	Bark	Mohamad *et al.*, 1999
	Amoora cucullata	Fruits	Chumkaew *et al.*, 2006
Rocagloic acid [**4.53**]	*A. dasyclada*	Leaves	Chaidir *et al.*, 2001
	A. rubiginosa	Twigs	Rivero-Cruz *et al.*, 2004
	Amoora cucullata	Fruits	Chumkaew *et al.*, 2006
Silvestrol [**4.54**]	*A. pyramidata*	Fruits	Hwang *et al.*, 2004
N-Tetrahydrofuran-rocaglamide [**4.55**]	*A. elliptica*	Fruits	Nugroho *et al.*, 1997b
Cyclopenta[*bc*]benzopyrans (aglains) Aglain A [**4.56**]	*A. argentea*	Leaves	Dumontet *et al.*, 1996
	A. forbesii	Barks	Dumontet *et al.*, 1996
Aglain B [**4.57**]	*A. argentea*	Leaves	Dumontet *et al.*, 1996
Aglain C [**4.58**]	*A. argentea*	Leaves	Dumontet *et al.*, 1996

Table 5. Distribution of flavagline compounds in the family Meliaceae. (continued)

Compounds	Source	part	References
Aglain -*O*-glycoside [**4.59**]	*A. dasyclada*	Leaves	Chaidir *et al.*, 2001
Aglaroxin J [**4.60**]	*A. roxburghiana*	Stem bark	Molleyres *et al.*, 1999
Aglaroxin K [**4.61**]	*A. roxburghiana*	Stem bark	Molleyres *et al.*, 1999
Aglaroxin L [**4.62**]	*A. roxburghiana*	Stem bark	Molleyres *et al.*, 1999
Aglaxiflorin A [**4.63**]	*A. laxiflora*	Leaves	Xu *et al.*, 2000
Aglaxiflorin B [**4.64**]	*A. laxiflora*	Leaves	Xu *et al.*, 2000
Aglaxiflorin D [**4.65**]	*A. laxiflora*	Leaves	Xu *et al.*, 2000
	A. testicularis	Leaves	Wang *et al.*, 2004
Desacetylaglain A [**4.66**]	*A. gracilis*	Leaves	Greger *et al.*, 2001
19,3′-Dihydroxyaglain C [**4.67**]	*A. odorata*	Twigs, Leaves	Nugroho *et al.*, 1999
Elliptifoline [**4.68**]	*A. elliptifolia*	Leaves	Wang *et al.*, 2001
Grandiamide A [**4.69**]	*A. grandis*	Leaves	Inada *et al.*, 2000
Homothapsakin A [**4.70**]	*A. edulis*	Roots	Bacher *et al.*, 1999
	A. oligophylla	Twigs	Dreyer *et al.*, 2001
19-Hydroxy-3′-methoxyaglain C [**4.71**]	*A. odorata*	Twigs, Leaves	Nugroho *et al.*, 1999
3′-Hydroxyaglain C (H-3α,H-4β) [**4.72**]	*A. odorata*	Twigs, Leaves	Nugroho *et al.*, 1999
3′-Hydroxyaglain C (H-3β,H-4α) [**4.73**]	*A. odorata*	Twigs, Leaves	Nugroho *et al.*, 1999
Isothapsakin B [**4.74**]	*A. edulis*	Roots	Bacher *et al.*, 1999
Thapsakin A 10-*O*-acetate [**4.75**]	*A. edulis*	Roots	Bacher *et al.*, 1999
(13*R*)-Thapsakin B [**4.76**]	*A. edulis*	Roots	Bacher *et al.*, 1999
(13*S*)-Thapsakin B [**4.77**]	*A. edulis*	Roots	Bacher *et al.*, 1999
Thapsakon A [**4.78**]	*A. edulis*	Roots	Bacher *et al.*, 1999

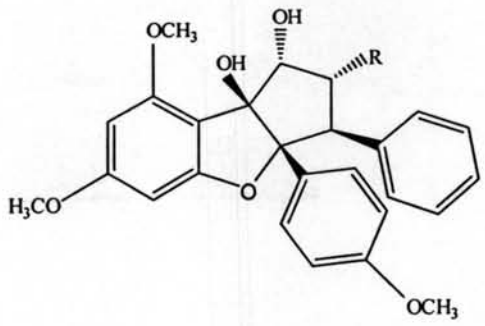
Table 5. Distribution of flavagline compounds in the family Meliaceae. (continued)

Compounds	Source	part	References
Thapsakon B **[4.79]**	*A. edulis*	Roots	Bacher *et al.*, 1999
Cyclopenta[*bc*]benzopyrans (aglaforbesins) Aglaforbesin A **[4.80]**	*A. forbesii*	Bark	Dumontet *et al.*, 1996
Aglaforbesin B **[4.81]**	*A. forbesii*	Bark	Dumontet *et al.*, 1996
Aglaxiflorin C **[4.82]**	*A. laxiflora*	Leaves	Xu *et al.*, 2000
Aglaforbesin –*O*-glycoside **[4.83]**	*A. dasyclada*	Leaves	Chaidir *et al.*, 2001
8-Demethoxy-7,8-methylenedioxyaglaforbesin **[4.84]**	*A. oligophylla*	Twigs	Dreyer *et al.*, 2001
Benzo[*b*]oxepines (forbaglines) Forbaglin A **[4.85]**	*A. forbesii*	Bark	Dumontet *et al.*, 1996
Forbaglin B **[4.86]**	*A. forbesii*	Bark	Dumontet *et al.*, 1996
Forbaglin-*O*-glycoside **[4.87]**	*A. dasyclada*	Leaves	Chaidir *et al.*, 2001
Homothapoxepine A **[4.88]**	*A. edulis*	Roots	Bacher *et al.*, 1999
4′-Hydroxy-10-acidic-21-deglycosyloxy forbaglin **[4.89]**	*A. dasyclada*	Leaves	Chaidir *et al.*, 2001
(13*R*)-Thapoxepine A **[4.90]**	*A. edulis*	Roots	Bacher *et al.*, 1999
(13*S*)-Thapoxepine A **[4.91]**	*A. edulis*	Roots	Bacher *et al.*, 1999
(13*R*)-Thapoxepine B **[4.92]**	*A. edulis*	Roots	Bacher *et al.*, 1999
(13*S*)-Thapoxepine B **[4.93]**	*A. edulis*	Roots	Bacher *et al.*, 1999

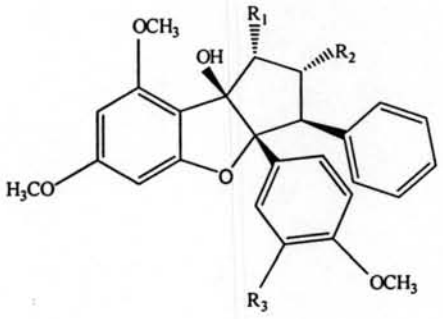


	R_1	R_2	R_3
1-*O*-Acetyldemethyl-rocaglamide **[4.2]**	$OCOCH_3$	$CONHCH_3$	H
1-*O*-Acetyl-didemethylrocaglamide **[4.4]**	$OCOCH_3$	$CONH_2$	H
1-*O*-Acetyl-3'-hydroxy-demethylrocaglamide **[4.5]**	$OCOCH_3$	$CONHCH_3$	OH
1-*O*-Acetyl-3'-hydroxy-methyl rocaglate **[4.6]**	$OCOCH_3$	$COOCH_3$	OH
1-*O*-Acetyl-3'-hydroxy-rocaglamide **[4.7]**	$OCOCH_3$	$CON(CH_3)_2$	OH
1-*O*-Acetyl-rocaglamide **[4.8]**	$OCOCH_3$	$CON(CH_3)_2$	H
1-*O*-Acetylmethyl rocaglate **[4.9]**	$OCOCH_3$	COOH	H
1-*O*-Acetylrocaglaol **[4.10]**	$OCOCH_3$	H	H
Desmethylrocaglamide **[4.21]**	OH	$CONHCH_3$	H
1-*O*-Formylmethyl rocaglate **[4.27]**	OCHO	$COOCH_3$	H
1-*O*-Formylrocagloic acid **[4.29]**	OCHO	COOH	H
3'-Hydroxy-1-*O*-formyloxy-methyl rocaglate **[4.32]**	OCHO	$COOCH_3$	OH
3'-Hydroxymethyl rocaglate **[4.35]**	OH	$COOCH_3$	OH
3'-Hydroxyrocaglamide **[4.36]**	OH	$CON(CH_3)_2$	OH
3'-Hydroxyrocagloic acid **[4.37]**	OH	COOH	OH
3'- Methoxy-methyl rocaglate **[4.40]**	OH	$COOCH_3$	OCH_3
3'- Methoxylrocaglaol **[4.42]**	OH	H	OCH_3
3'- Methoxyrocaglamide **[4.43]**	OH	$CON(CH_3)_2$	OCH_3

Figure 6. Chemical structures of flavagline compounds in the family Meliaceae

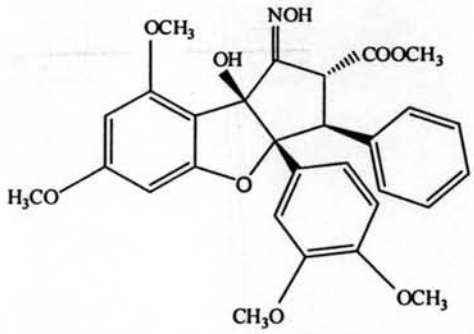


	R
Methyl rocaglate (Aglafoline) **[4.45]**	$COOCH_3$
Rocaglamide **[4.50]**	$CON(CH_3)_2$
Rocaglaol **[4.52]**	H
Rocagloic acid **[4.53]**	COOH

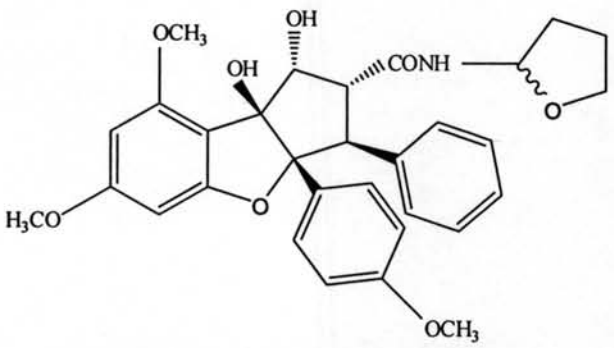


	R_1	R_2	R_3
1-*O*-Acetyl-N-butanoyl-didesmethyl-rocaglamide **[4.1]**	$OCOCH_3$	$CONH(CH_2)_4OH$	H
N-butanoyl-didesmethylrocaglamide **[4.12]**	OH	$CONH(CH_2)_4OH$	H
Didesmethylrocaglamide **[4.22]**	OH	$CONH_2$	H
3'-Hydroxydemethyl- rocaglamide **[4.31]**	OH	$CONHCH_3$	OH
3'-Hydroxydidemethyl-rocaglamide **[4.33]**	OH	$CONH_2$	OH

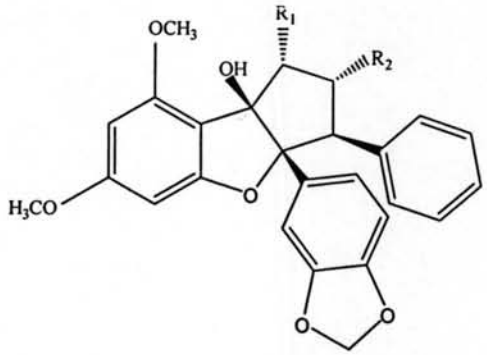
Figure 6. Chemical structures of flavagline compounds in the family Meliaceae (continued)



1-Oxime-3'-methoxy- methylrocaglate [**4.47**]

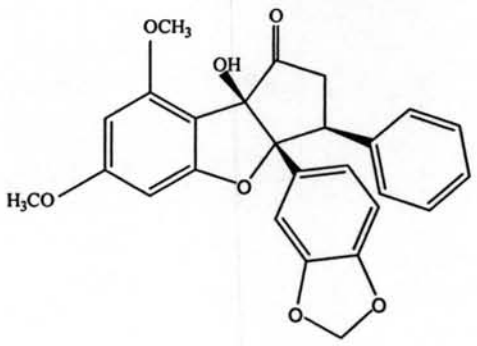


N-Tetrahydrofuran-rocaglamide [**4.55**]

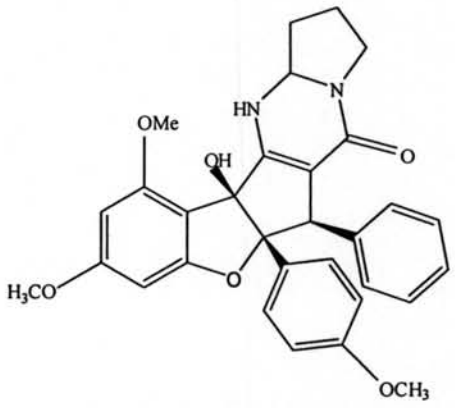


	R_1	R_2
1-*O*-Acetyl-4'-demethoxy-3',4'-methylenedioxy-methyl rocaglate [**4.3**]	$OCOCH_3$	$COOCH_3$
4'-Demethoxy-3', 4'-methylenedioxy-methyl rocaglate [**4.16**]	OH	$COOCH_3$
4'-Demethoxy-3',4'-methylenedioxyrocaglaol [**4.19**]	OH	H
1-*O*-Formyloxy-4'-demethoxy-3',4'-methylenedioxy-methyl rocaglate [**4.28**]	OCHO	$COOCH_3$

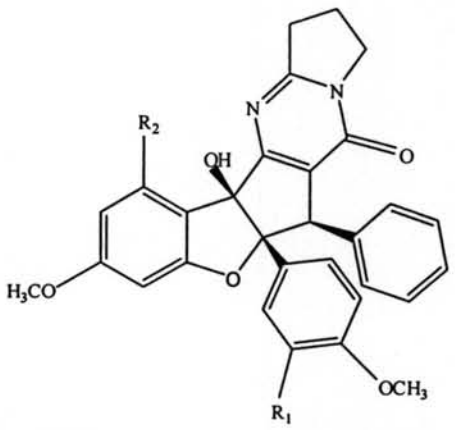
Figure 6. Chemical structures of flavagline compounds in the family Meliaceae (continued)



1-Oxo-4'-demethoxy-3',4'-methylenedioxy rocaglaol [**4.20**]

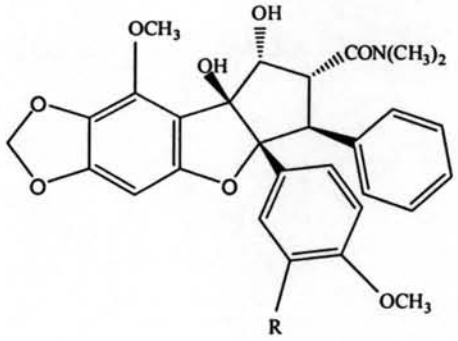


Aglaiastatin (aglaroxin D) [**4.11**]

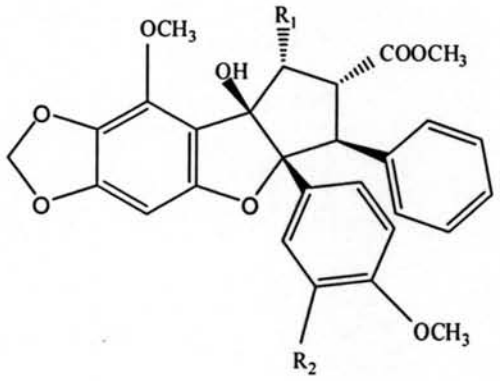


Dehydroaglaiastatin [**4.14**]	:R_1 = H, R_2 = OCH_3
3'-Hydroxy-dehydroaglaiastatin [**4.30**]	:R_1 = OH, R_2 = OCH_3
3'-Hydroxymarikarin [**4.34**]	:R = OH, R_2 = OH
Marikarin [**4.38**]	:R = H, R_2 = OH

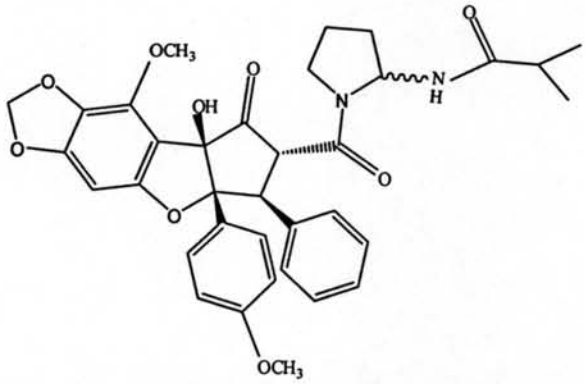
Figure 6. Chemical structures of flavagline compounds in the family Meliaceae (continued)



	R
6-Demethoxy-6,7-methylenedioxy rocaglamide (aglaroxin A) **[4.18]**	H
3'-Methoxyl-6-demethoxy-6,7-methylenedioxy rocaglamide **[4.39]**	OCH_3

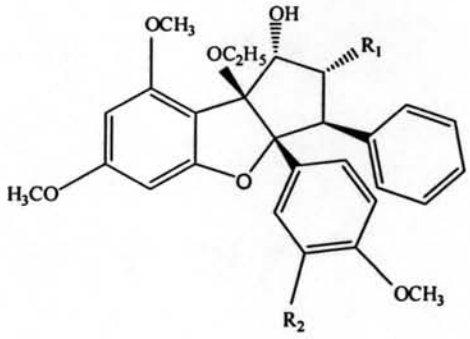


	R_1	R_2
6-Demethoxyl-6,7-methylenedioxymethylrocaglate (Pannellin) **[4.17]**	OH	H
3'-Methoxypannellin **[4.41]**	OH	OCH_3
Pannellin 1-*O*-acetate **[4.49]**	$OCOCH_3$	H

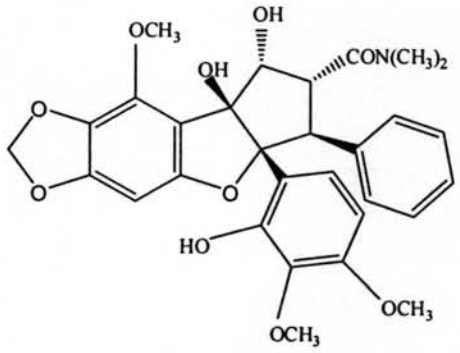


1-Oxo-2-piriferine-6-demethoxy-6,7-methylenedioxy rocaglamide **[4.48]**

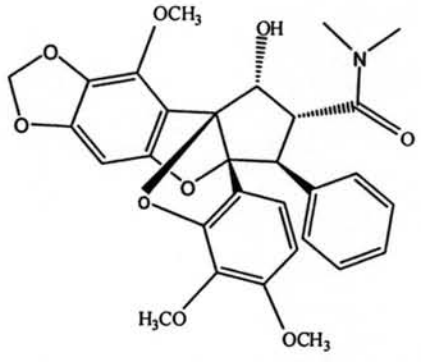
Figure 6. Chemical structures of flavagline compounds in the family Meliaceae (continued)



	R_1	R_2
8b-*O*-Ethyl-demethylrocaglamide **[4.24]**	$CONHCH_3$	OC_2H_5
8b-*O*-Ethyl-3'-hydroxyrocaglamide **[4.25]**	$CON(CH_3)_2$	OC_2H_5
Ethylrocaglaol **[4.26]**	H	H



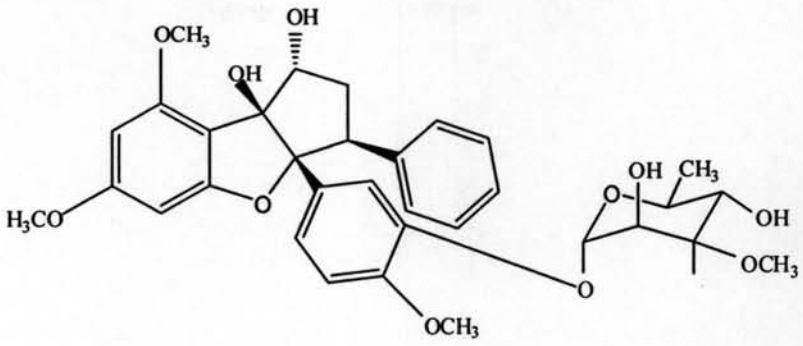
6-Demethoxy-2'-hydroxy-3'-methoxy-6,7-methylenedioxy rocaglamide **[4.15]**



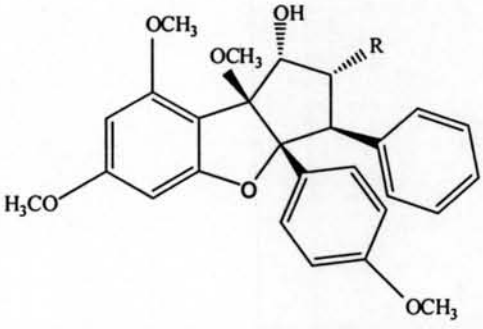
Cyclorocaglamide

(6-demethoxy-8b,2'-epoxy-3'-methoxy-6,7-methylenedioxyrocaglamide) **[4.13]**

Figure 6. Chemical structures of flavagline compounds in the family Meliaceae (continued)

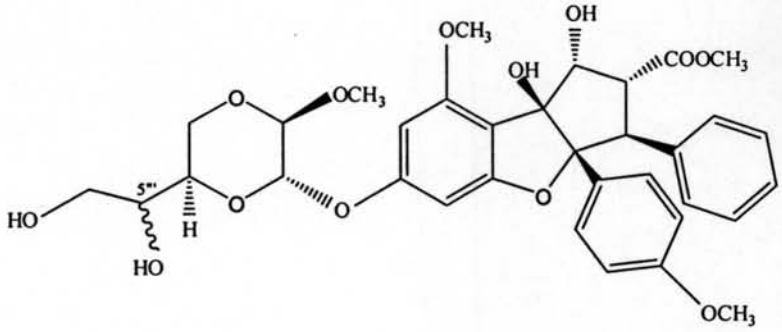


Rocaglaol-3'-rhamnose [**4.51**]



8b-*O*-methyl-methyl rocaglate [**4.44**] :R = $COOCH_3$

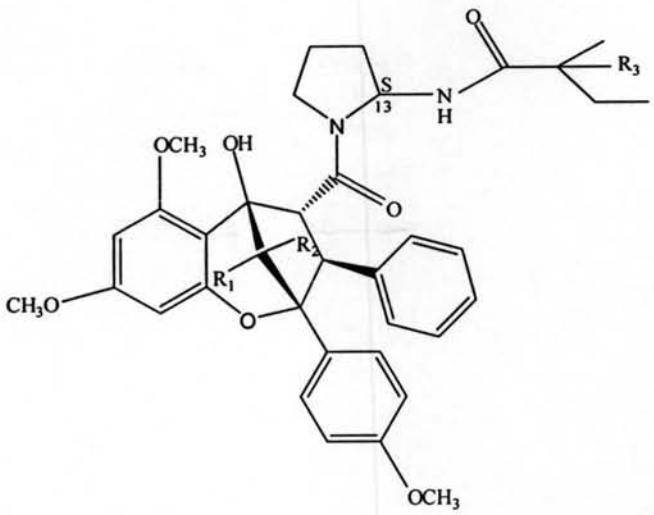
8b-*O*-methylrocaglaol [**4.46**] :R = H



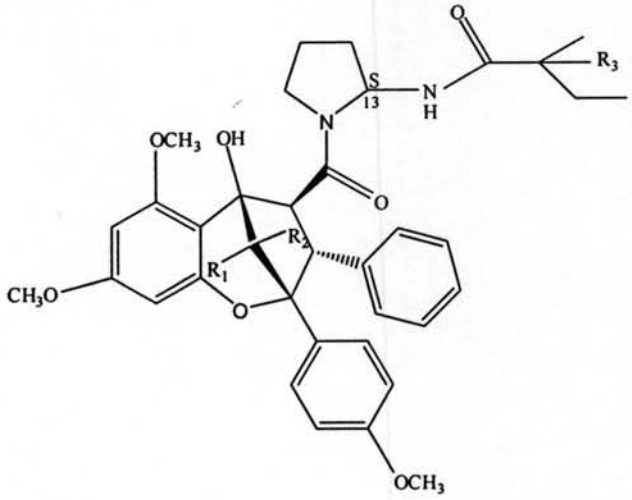
Episilvestrol [**4.23**] (5‴*S*)

Silvestrol [**4.54**] (5‴*R*)

Figure 6. Chemical structures of flavagline compounds in the family Meliaceae (continued)

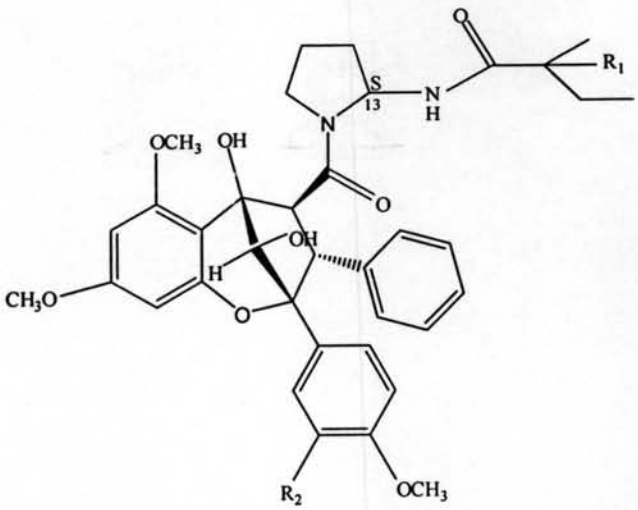


	R_1	R_2	R_3
Aglain A [**4.56**]	OAc	H	H
Aglain B [**4.57**]	H	OH	H
Aglaxiflorin A [**4.63**]	OAc	H	OH
Desacetylaglain A [**4.66**]	OH	H	H

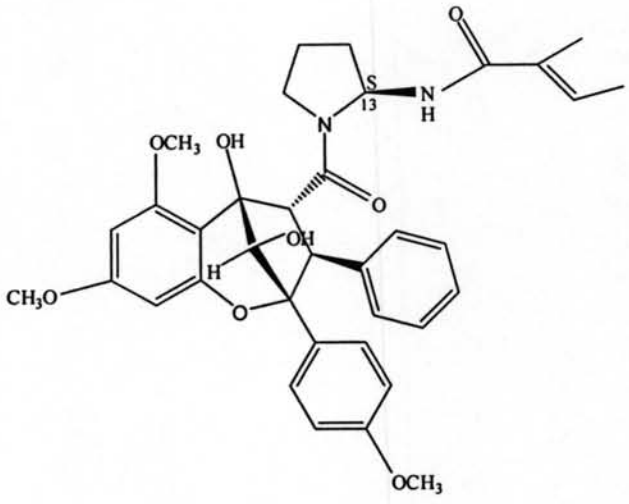


	R_1	R_2	R_3
Aglain C [**4.58**]	OH	H	H
Aglaroxin J [**4.60**]	H	OAc	H
Aglaroxin K [**4.61**]	H	OH	H
Aglaroxin L [**4.62**]	H	OH	OH
Aglaxiflorin B [**4.64**]	OAc	H	OH
Aglaxiflorin D [**4.65**]	H	OH	OH

Figure 6. Chemical structures of flavagline compounds in the family Meliaceae (continued)

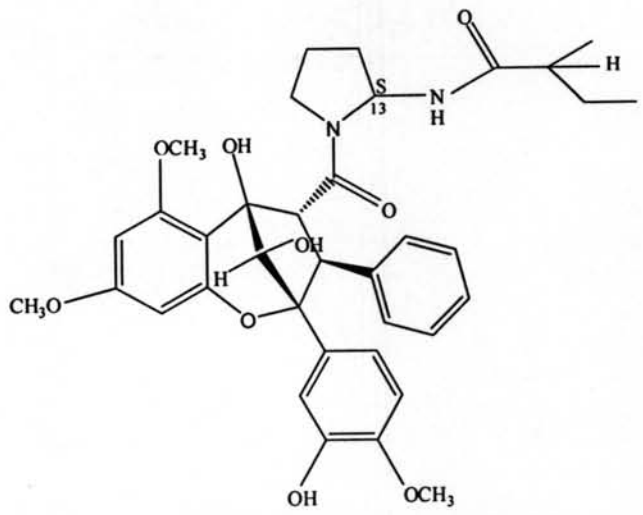


	R_1	R_2
19,3′-Dihydroxyaglain C **[4.67]**	OH	OH
19-Hydroxy-3′-methoxyaglain C **[4.71]**	OH	OCH_3
3′-Hydroxyaglain C **[4.72]**	H	OH
Homothapsakin A **[4.70]**	H	H

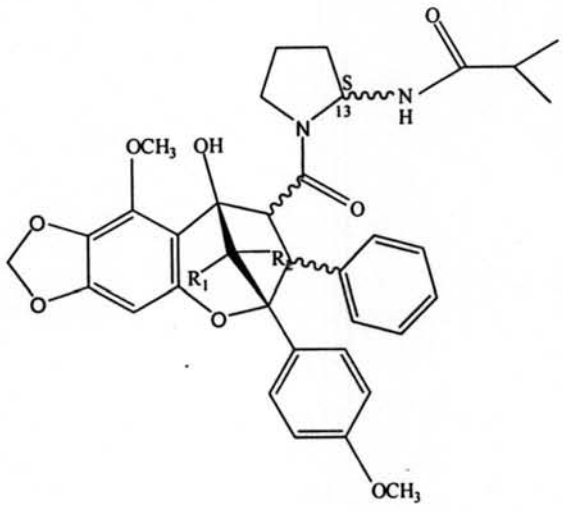


Elliptifoline **[4.68]**

Figure 6. Chemical structures of flavagline compounds in the family Meliaceae (continued)

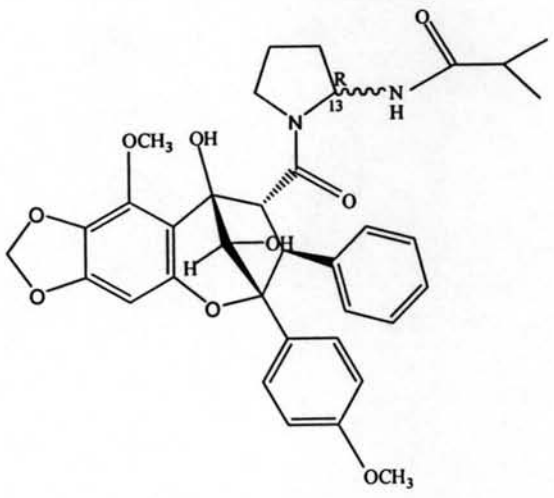


3′-Hydroxyaglain C [**4.73**]

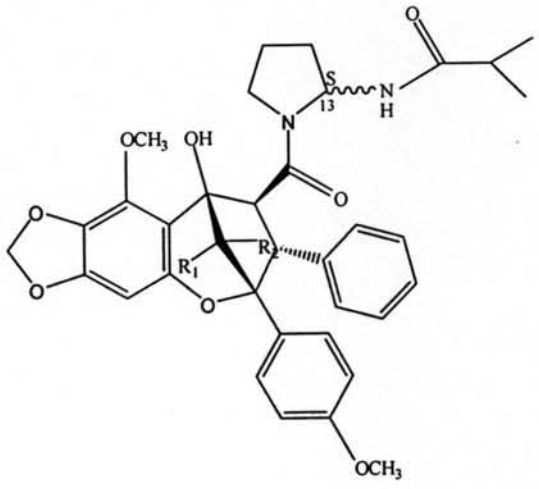


	R_1	R_2
Isothapsakin B [**4.74**] (H-3β,H-4α)	OH	H
Thapsakin A 10-*O*-acetate [**4.75**] (H-3α,H-4β)	H	OAc
(13*S*)-Thapsakin B [**4.77**] (H-3β,H-4α)	H	OH

Figure 6. Chemical structures of flavagline compounds in the family Meliaceae (continued)

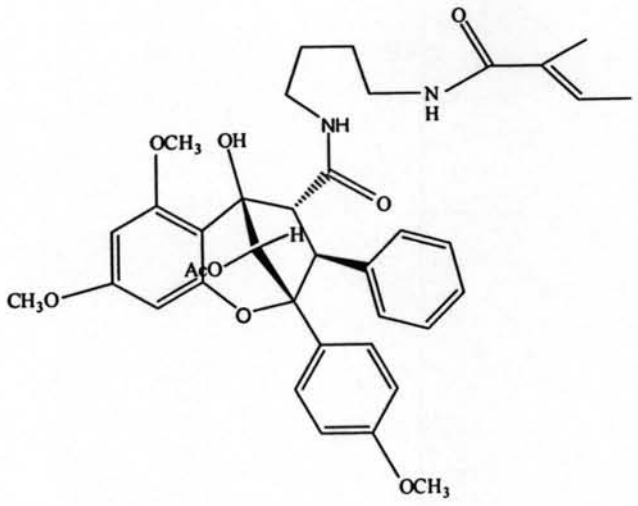


(13*R*)-Thapsakin B [**4.76**]

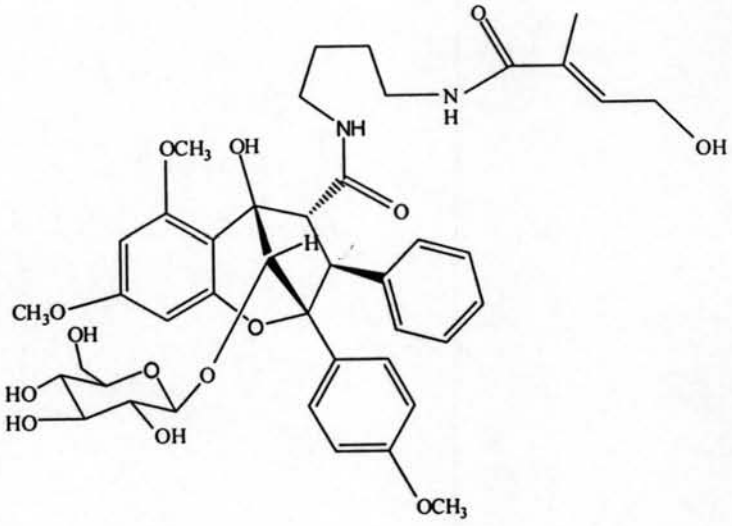


	R_1	R_2
Thapsakon A [**4.78**] (H-3α,H-4β)	= O	
Thapsakon B [**4.79**] (H-3β,H-4α)	= O	

Figure 6. Chemical structures of flavagline compounds in the family Meliaceae (continued)

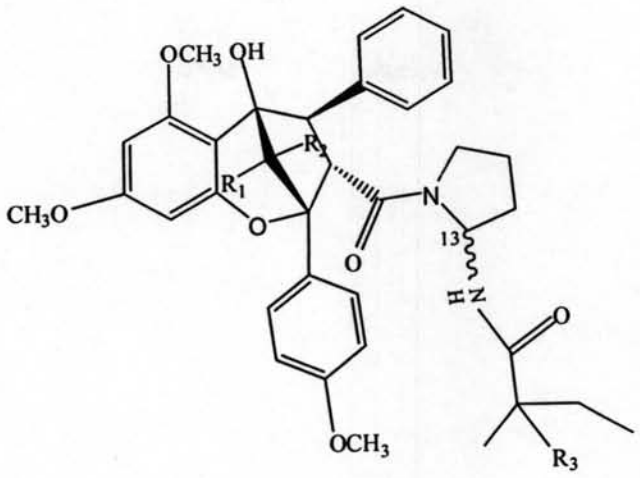


Grandiamide A [**4.69**]

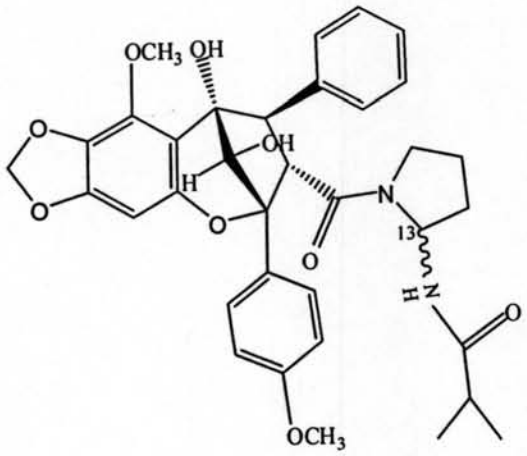


Aglain -*O*-glycoside [**4.59**]

Figure 6. Chemical structures of flavagline compounds in the family Meliaceae (continued)

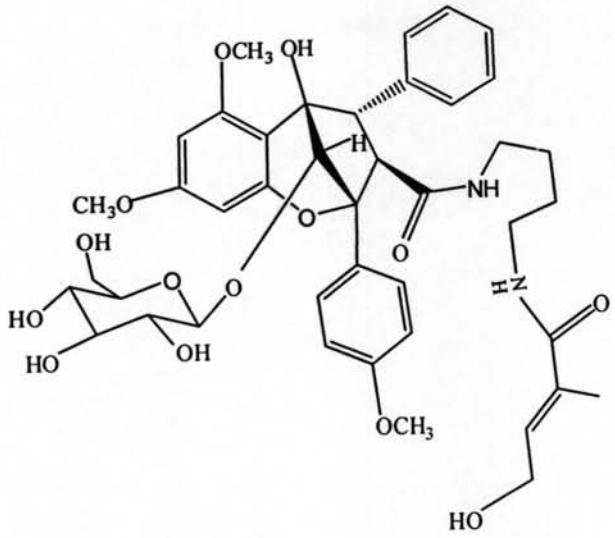


	R_1	R_2	R_3
Aglaforbesin A [**4.80**] (13R)	OH	H	H
Aglaforbesin B [**4.81**] (13R)	H	OH	H
Aglaxiflorin C [**4.82**] (13*S*)	H	OAc	OH

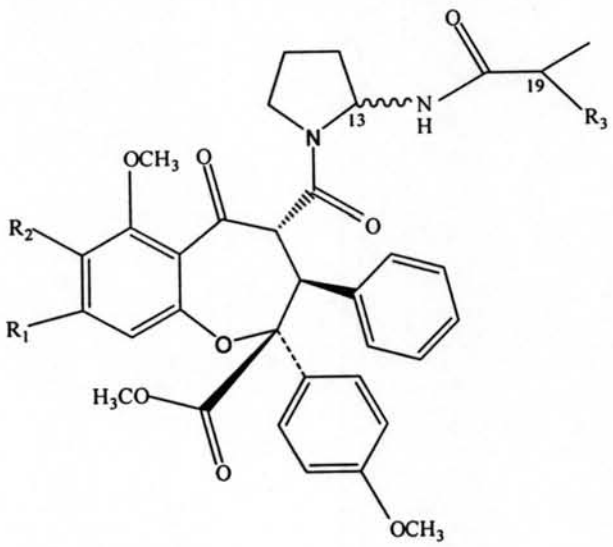


8-Demethoxy-7,8-methylenedioxyaglaforbesin [**4.84**]

Figure 6. Chemical structures of flavagline compounds in the family Meliaceae (continued)

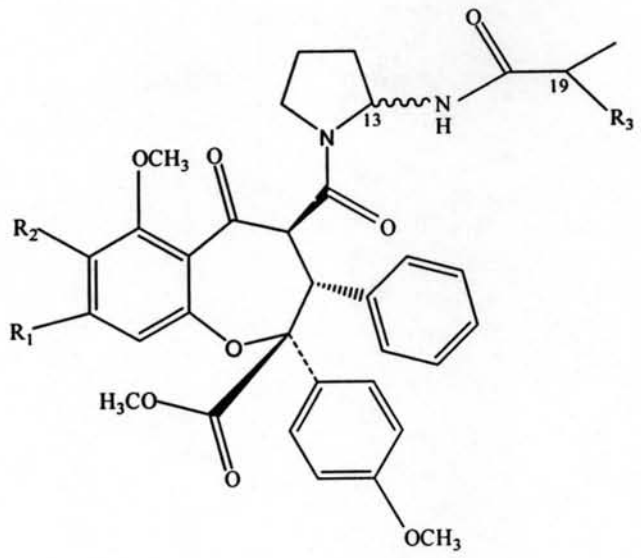


Aglaforbesin –*O*-glycoside [**4.83**]

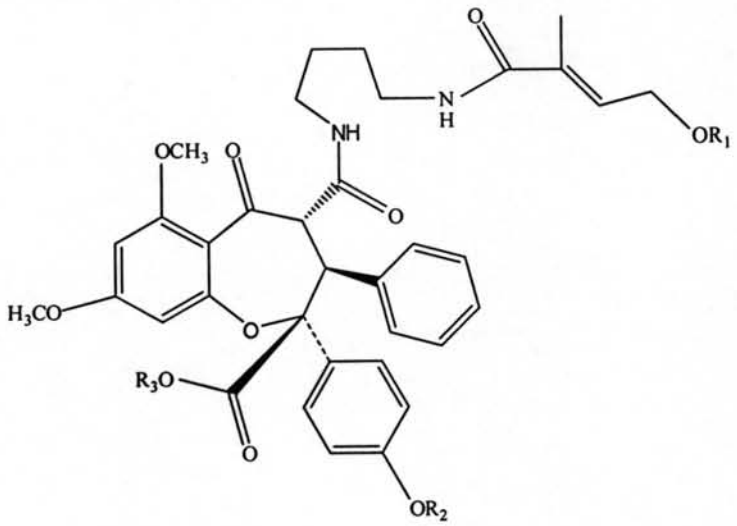


	R_1	R_2	R_3
Forbaglin A [**4.85**] (13*R*) (19*S*)	OCH_3	H	C_2H_5
Forbaglin B [**4.86**] (13*S*)	OCH_3	H	C_2H_5
(13*R*)-Thapoxepine B [**4.92**] (13*R*)	$-OCH_2O-$		CH_3
(13*S*)-Thapoxepine B [**4.93**]	$-OCH_2O-$		CH_3

Figure 6. Chemical structures of flavagline compounds in the family Meliaceae (continued)



	R_1	R_2	R_3
Homothapoxepine A [**4.88**] (13*S*)		-OCH_2O-	C_2H_5
(13*R*)-Thapoxepine A [**4.90**] (13*R*)		-OCH_2O-	CH_3
(13*S*)-Thapoxepine A [**4.91**] (13*S*)		-OCH_2O-	CH_3



	R_1	R_2	R_3
Forbaglin-*O*-glycoside [**4.87**]	Glucose	CH_3	CH_3
4′-Hydroxy-10-acidic-21-deglycosyloxy forbaglin [**4.89**]	H	H	H

Figure 6. Chemical structures of flavagline compounds in the family Meliaceae (continued)