CHAPTER II

HISTORICAL

PLANTS IN THE GENUS *AGLAIA*

Family Meliaceae comprises 50 (or 51) genera with about 575 species. The family is best represented in the Malesian region. Almost half of the Malayan species are in the single genus *Aglaia*, which is restricted to Indomalesia and the western Pacific (Mabberley and Pannell 1989).

The genus *Aglaia* consists of some 130 species. According to Craib (1931), Smitinand (1980) and Pannell (1992), there are about 48 species of *Aglaia* in Thailand.

These species are:

Aglaia andamanica Hiem

A. argentea Blume

A. aspera Teijsm.&Binn.***

A. caudata Hiem**

A. chaudocensis Pierre

A. chittagonga Miq.***

A. cordata Hiem

A. crassinervia Kurz ex Hiem***

A. cucullata (Roxb.) Pelleg.***

A. domestica Pelleg.**

A. dookkoo Griff**

A. edulis A. Gray

A. elaeagnoidea (A. Juss.) Benth.***

A. *elliptica* Blume***

A. *erythrosperma* C. M. Pannell***

A. *eximia* Miq.***

A. *exstipulata* (Griffith) Theobald***

A. *forbesii* King***

A. *gigantea* Pelleg.**

A. *grandis* Korth. In Miq.***

A. *hoaensis* Pierre

A. *korthalsii* Miq.***

A. *kunsteri* King*

A. *lawii* (Wight) Saldanha ex Ramamoorthy***

A. *leptantha* Miq.***

A. *leucophylla* King***

A. *marginata* Craib*

A. *meliosmoides* Craib

A. *merostela* Pelleg.*

A. *oblanceolata* Craib*

A. *odorata* Lour.

A. *odoratissima* Blume

A. *oligophylla* Miq.***

A. *pachyphylla* Miq.***

A. *palembanica* Miq.

A. *paniculata* Kurz*

A. *perviridis* Hiem***

A. *pirifera* Hance

A. *pyramidata* Hance

A. *quocensis* Pierre*

A. *silvestris* (M. Roemer) Merrill***

A. *simplicifolia* (Bedd.) Harms***

A. spectabilis (Miq.) Jain&Bennet***

A. submonophylla Miq*

A. tenuicaulis Hiem

A. teysmanniana (Miq.) Miq.***

A. tomentosa Teijsm.&Binn.***

A. trichostemon DC.*

*reported by Craib only

**reported by Smitinand only

***reported by Pannell only

CHEMICAL CONSTITUENTS OF *AGLAIA* SPECIES

Plants in the genus *Aglaia* are found to content a wide range of chemical constituents such as alkaloids (Brader *et al.*,1998), terpenoids (Omobuwajo *et al.*,1996) and other compounds (Fuzzati *et al.*,1996).

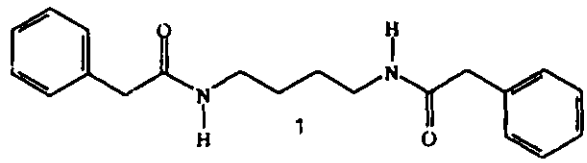
Alkaloid constituents of the genus *Aglaia*

The earliest report of alkaloid constituents in the genus *Aglaia* was that of Shiengthong and his co-workers (1979). In this study, two alkaloids of the bisamide type, named odorine and odorinol were isolated from the leaves of *Aglaia odorata* Lour. Further investigation of the alkaloids from plants in the genus *Aglaia* are summarized in Table 1.

Table 1 Alkaloid constituents of the genus *Aglaia*

Plant Name	Chemical Constituents	Reference
Aglaia edulis	Aglaiduline (1)	Saifah *et al.*,1999
	Aglaithioduline (2)	Saifah *et al.*,1999
	Aglaidithioduline (3)	Saifah *et al.*,1999
	Edulimide (4)	Brader *et al.*,1998
	Piriferinol (5)	Brader *et al.*,1998
Aglaia formosana	Dehydroodorin (6)	Duh *et al.*,1993
Aglaia odorata	Odoram (7)	Techasauwapak,1981
	Odorine (8)	Shiengthong *et al.*,1979; Hayashi *et al.*,1982
	Odorinol (9)	Shiengthong *et al.*,1979; Hayashi *et al.*,1982
Aglaia pirifera	Piriferine (10)	Saifah, Jongbunprasert and Kelly,1988
Aglaia pyramidata	Pyramidatine (11)	Saifah *et al.*,1993
Aglaia roxburghiana	(+)-Odorine (8)	Purushothaman *et al.*, 1979 ; Joshi *et al.*,1987
	(+)-Odorinol (9)	Joshi *et al.*,1987
Aglaia rubiginosa	Aglairubine (12)	Saifah and Suparakchinda, 1998

All the compounds are bisamide alkaloids isolated from the leaves of these plants except odoram, a piperidine alkaloid isolated from flower of *A.odorata.*



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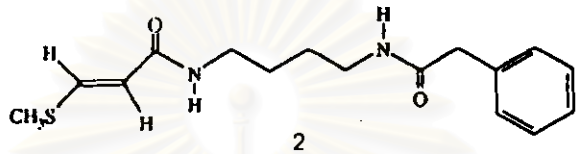

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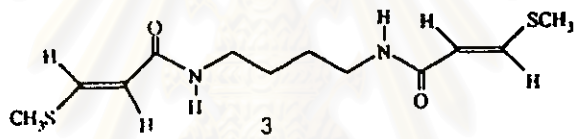

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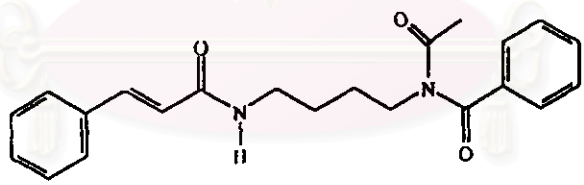

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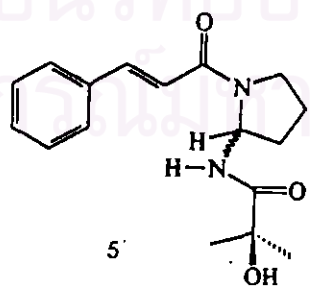

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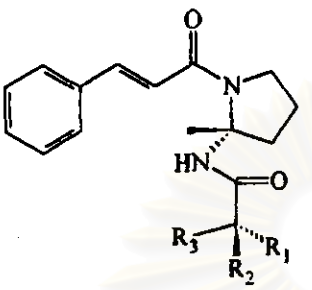
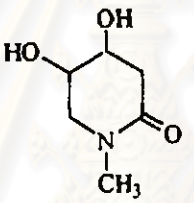


6 $R_1 = H; R_2 = CH_3; R_3 = CHCH_3$

8 $R_1 = CH_3; R_2 = CH_3; R_3 = CH_2CH_3$

9 $R_1 = H; R_2 = CH_3; R_3 = CH_2CH_3$

10 $R_1 = H; R_2,R_3 = CH_3$



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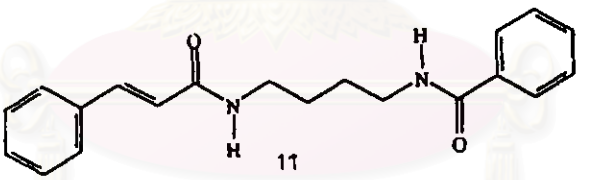

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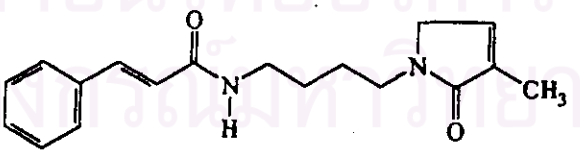

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Other chemical constituents of the genus *Aglaia*

These other chemical constituents of the genus *Aglaia* comprised mainly of terpenoids and other constituents such as benzofurans, lignans and steroids etc. The list of such constituents are summarized in Table 2.

Table 2. Other chemical constituents of the genus *Aglaia*

Plant Name	Part	Chemical Constituents	Category	References
Aglaia andamanica	Leaf	Aglaiodiol (13)	Triterpenoid	Puripattanavong *et al.*,1999
		β-Sitosterol (14)	Steroid	Puripattanavong *et al.*,1999
		24-Epimelianodiol (15)	Limonoid	Puripattanavong *et al.*,1999
		24-Epipisidinol A (16)	Triterpenoid	Puripattanavong *et al.*,1999
		Melianodiol (17)	Limonoid	Puripattanavong *et al.*,1999
		N-methyl-trans-L-proline (18)	Amino acid	Puripattanavong *et al.*,1999
		Yangambin (19)	Lignan	Puripattanavong *et al.*,1999
Aglaia argentea	Leaf	Argenteanol A (20)	Cycloartane triterpenoid	Omobuwajo *et al.*,1996a
		Argenteanol B(21)	Cycloartane triterpenoid	Mohamad *et al.*,1997
		Argenteanol C (22)	Cycloartane triterpenoid	Mohamad *et al.*,1997
		Argenteanol D (23)	Cycloartane triterpenoid	Mohamad *et al.*,1997
		Argenteanol E (24)	Cycloartane triterpenoid	Mohamad *et al.*,1997
		Argenteanone A (25)	Cycloartane triterpenoid	Omobuwajo *et al.*,1996a
		Argenteanone B (26)	Cycloartane triterpenoid	Omobuwajo *et al.*,1996a
		Argenteanone C(27)	Cycloartane triterpenoid	Mohamad *et al.*,1997

Table 2. Other chemical constituents of the genus *Aglaia* continued

Plant Name	Part	Chemical Constituents	Category	References
		Argenteanone D (28)	Cycloartane triterpenoid	Mohamad *et al.*,1997
		Argenteanone E (29)	Cycloartane triterpenoid	Mohamad *et al.*,1997
	Seed	Gentinin (30)	Apotirucallane triterpenoid	Omobuwajo *et al.*,1996b
		Gentinone A (31)	Apotirucallane triterpenoid	Omobuwajo *et al.*,1996b
		Gentinone B (32)	Apotirucallane triterpenoid	Omobuwajo *et al.*,1996b
		Gentinone C (33)	Apotirucallane triterpenoid	Omobuwajo *et al.*,1996b
		Gentinone D(34)	Apotirucallane triterpenoid	Omobuwajo *et al.*,1996b
Aglaia duppereana	Twig	Desmethylrocaglamide (35)	Benzofuran	Nugroho *et al.*,1997a
		Rocaglamide (36)	Benzofuran	Nugroho *et al.*,1997a
		Rocaglamide derivative (37)	Benzofuran	Nugroho *et al.*,1997a
		Rocaglamide derivative (38)	Benzofuran	Nugroho *et al.*,1997a
		Rocaglamide derivative (39)	Benzofuran	Nugroho *et al.*,1997a
		Rocaglamide derivative (40)	Benzofuran	Nugroho *et al.*,1997a
		Rocaglamide derivative (41)	Benzofuran	Nugroho *et al.*,1997a
Aglaia elaeagnoidea	Bark	6α,11β-Diacetoxygedunin (42)	Limonoid	Fuzzati *et al.*,1996

Table 2. Other chemical constituents of the genus *Aglaia* continued

Plant Name	Part	Chemical Constituents	Category	References
		1,8*b*-Dihydroxy-6,8-dimethoxy-3a-(4-methoxyphenyl)-3-phenyl-,3,3a,8b-tetrahydrocyclopenta[*b*]-benzofuran-2(1H)-carboxylate (**43**)	Benzofuran	Fuzzati *et al.*,1996
		20*S*,24*S*-Epoxy-25-hydroxydammaran-3-one (**44**)	Dammarane triterpenoid	Fuzzati *et al.*,1996
		20*S*,24*S*-Epoxy-25-hydroxymethyl-dammarane-3-one (**45**)	Dammarane triterpenoid	Fuzzati *et al.*,1996
		trans-2,3-*Bis*(3,4,5-trimethoxybenzyl)-1,4-butanediol diacetate (**46**)	Lignan	Fuzzati *et al.*,1996
		trans-3,4-*Bis*(3,4,5-trimethoxybenzyl) tetrahydrofuran (**47**)	Lignan	Brader *et al.*,1998
	Leaf	28,29-*bis*-Norcycloarten-3β,6α-diol (**48**)	Cycloartane triterpenoid	Brader *et al.*,1998
		29,29-*bis*-Norcycloarten-3β,4α,6α-triol (**49**)	Cycloartane triterpenoid	

Table 2. Other chemical constituents of the genus *Aglaia* continued

Plant Name	Part	Chemical Constituents	Category	References
		3β-Hydroxy-28,29-*bis*-norcycloarten-6-one (50)	Cycloartane triterpenoid	Brader *et al.*,1998
		3β-Hydroxy-24-methylene-28,29-*bis*-norcycloartan-6-one (51)	Cycloartane triterpenoid	Brader *et al.*,1998
		(+)-Lariciresinol 3-acetate (52)	Lignan	Brader *et al.*,1998
		24-Methylene-28,29-*bis*-norcycloartan-3β,4α,6α-triol (53)	Cycloartane triterpenoid	Brader *et al.*,1998
		Roxburghiadiol B(54)	Cycloartane triterpenoid	Brader *et al.*,1998
	Leaf,Stem & Root bark	Aglalactone (55)	Benzofuran	Brader *et al.*,1998
		(-)-3'-Methoxypannellin (56)	Benzofuran	Brader *et al.*,1998
		(-)-Pannellin (57)	Benzofuran	Brader *et al.*,1998
		(-)-Pannellin 1-O-acetate (58)	Benzofuran	Brader *et al.*,1998
Aglaia elliptifolia	Root&Stem	Dehydrorocaglamide (59)	Benzofuran	King *et al.*,1982

Table 2. Other chemical constituents of the genus *Aglaia* continued

Plant Name	Part	Chemical Constituents	Category	References
	Stem bark	Rocaglamide (36)	Benzofuran	King *et al.*,1982
		Aglafoline (60)	Benzofuran	Ko *et al.*,1992; Wu *et al.*, 1997
Aglaia elliptica	Fruit	Rocaglamide (36)	Benzofuran	Nugroho *et al.*,1997b
		Rocaglamide derivative (61)	Benzofuran	Nugroho *et al.*,1997b
		Rocaglamide derivative (62)	Benzofuran	Nugroho *et al.*,1997b
		Rocaglamide derivative (63)	Benzofuran	Nugroho *et al.*,1997b
		Rocaglamide derivative (64)	Benzofuran	Nugroho *et al.*,1997b
Aglaia ferruginaea	Heartwood	7-Deacetylglabretal-3-acetate (65)	Protolimonoid	Mulholland and Monkhe, 1993
		7-Deacetylglabretal-3-tiglate (66)	Protolimonoid	
	Powder-Bark	Rocaglaol (67)	Benzofuran	Dean *et al.*,1993 ; Mulholland and Naidoo, 1998
Aglaia forbesii	Bark	Rocaglaol (67)	Benzofuran	Dumontet *et al.*,1996

Table 2. Other chemical constituents of the genus *Aglaia* continued

Plant Name	Part	Chemical Constituents	Category	References
Aglaia grandis	Leaf	2β,3β-Dihydroxy-5α-pregnane-6-one (68)	Pregnane triterpenoid	Inada *et al.*,1997a
		2β,3β-Dihydroxy-5α-pregn-17(20)-(*Z*) -en-16-one (69)	Pregnane triterpenoid	Inada *et al.*,1997a
		2β,3β-Dihydroxy-5α-pregn-17(20)-(*E*) -en-16-one (70)	Pregnane triterpenoid	Inada *et al.*,1997a
		25-Hydroperoxycycloart-23-en-3β-ol (71)	Cycloartane triterpenoid	Inada *et al.*,1997a
		24-Hydroperoxycycloart-25-en-3β-ol (72)	Cycloartane triterpenoid	Inada *et al.*,1997a
		(+)Yangambin (19)	Lignan	Brader *et al.*,1998
Aglaia harmsiana	Leaf	Cycloartane-3β,29-diol-24-one (73)	Cycloartane triterpenoid	Inada *et al.*,1995
		(24R)-Cycloartane-24,25-diol-3-one (74)	Cycloartane triterpenoid	Inada *et al.*,1995
		(24R)-Cycloartane-3α,24,25,triol (75)	Cycloartane triterpenoid	Inada *et al.*,1997b
		(24R)-Cycloartane-3β,24,25-triol (76)	Cycloartane triterpenoid	Inada *et al.*,1997b
		Rocaglamide (36)	Benzofuran	Nugroho *et al.*,1997b

Table 2. Other chemical constituents of the genus *Aglaia* continued

Plant Name	Part	Chemical Constituents	Category	References
Aglaia harmsiana	Leaf	Rocaglamide derivative (61)	Benzofuran	Nugroho *et al.*,1997b
		Rocaglamide derivative (62)	Benzofuran	Nugroho *et al.*,1997b
		Rocaglamide derivative (63)	Benzofuran	Nugroho *et al.*,1997b
		Rocaglamide derivative (64)	Benzofuran	Nugroho *et al.*,1997b
Aglaia leucophylla	Stem bark	(-)-Bourjotinolone (77)	Tirucallane triterpenoid	Benosman *et al.*,1995
		(+)-Cabraleone (78)	Dammarane triterpenoid	Benosman *et al.*,1995
		(+)-Eichlerianic acid (79)	Dammarane triterpenoid	Benosman *et al.*,1995
		(-)-Leucophyllone (80)	Tirucallane triterpenoid	Benosman *et al.*,1995
		(-)-Niloticin (81)	Tirucallane triterpenoid	Benosman *et al.*,1995
		(+)-Ocotillone (82)	Dammarane triterpenoid	Benosman *et al.*,1995
		(24*Z*)-3,4-Secotirucalla-4(28),7,24-triene-3,26-dioic acid (83)	Secotirucallane-Triterpenoid	Benosman *et al.*,1994
		(24*Z*)-3,4-Secotirucalla-4(28),7,24-triene-3-methyloate-26-oic acid (84)	Secotirucallane-Triterpenoid	Benosman *et al.*,1994
Aglaia odorata	Leaf	Aglaiol (85)	Dammarane triterpenoid	Shiengthong *et al.*,1965; Boar and Damps,1973

Table 2. Other chemical constituents of the genus *Aglaia* continued

Plant Name	Part	Chemical Constituents	Category	References
		Aglaiondiol (86)	Dammarane triterpenoid	Shiengthong *et al.*,1974; Boar and Damps,1977
		Aglaitriol (87)	Dammarane triterpenoid	Shiengthong *et al.*,1974; Boar and Damps,1977
		Desmethylrocaglamide (35)	Benzofuran	Ishibashi *et al.*,1993
		Rocaglamide (36)	Benzofuran	Ishibashi *et al.*,1993 ; Janprasert *et al.*,1993
	Root	Methylrocaglate (88)	Benzofuran	Ishibashi *et al.*,1993
		Rocaglaol (67)	Benzofuran	Ishibashi *et al.*,1993
		Aglaiastatin (89)	Lignan	Ohse *et al.*,1996 ; Watanabe *et al.*,1998
	Twig	Pyrimidinone (90)	Benzofuran	Kokpol *et al.*,1994 ; Watanabe *et al.*,1998
Aglaia oligophylla	Twig	Rocaglamide (36)	Benzofuran	Janprasert *et al.*,1993
Aglaia pirifera	Stem bark	Rocaglamide (36)	Benzofuran	Hwunseng *et al.*,1995
		Desmethylrocaglamide (35)	Benzofuran	Hwunseng *et al.*,1995
		Grandisin (91)		

Table 2. Other chemical constituents of the genus *Aglaia*

Plant Name	Part	Chemical Constituents	Category	References
Aglaia pirifera	Stem bark	Grandisin (91)	Lignan	Ngowgarmratana and Saifah,1987
Aglaia pyramidata	Leaf	N-Methyl-*trans*–4-hydroxy-L-proline (18)	Amino acid	Saifah and Puipattanavong ,1992
Aglaia roxburghiana	Aerial-Part	28,29-Bis-norcycloartane-24-methylene-3β-6α-diol (92)	Cycloartane triterpenoid	Vishnoi *et al.*,1988
		29-Norcycloartan-23-ene-3β-25-diol (93)	Cycloartane triterpenoid	Vishnoi *et al.*,1988
		29-Norcycloartan-24,25-epoxy-3β-ol (94)	Cycloartane triterpenoid	Vishnoi *et al.*,1988
		29-Norcycloartenol (95)	Cycloartane triterpenoid	Vishnoi *et al.*,1988
	Leaf &	Roxburghiadiol A (96)	Triterpenoid	Purushothaman *et al.*,1986
	Fruit	Roxburghiadiol B (97)	Triterpenoid	Purushothaman *et al.*,1986
Aglaia rubiginosa	Leaf	Choles-5-ene-3,4,22-triol (98)	Steroid	Weber *et al.*,1999
		Choles-7-ene-2,3,4,22,25-pentol (99)	Steroid	Weber *et al.*,1999
Aglaia tomentosa	Leaf	(+)-Methylarctigenin (100)	Lignan	Brader *et al.*,1998

Pharmacological activities of extracts and active constituents of *Aglaia* species

Several species of *Aglaia* are traditionally used in folk medicine in South-East Asia (Perry,1980). Various extracts from *Aglaia* species were shown to be pharmacologicaly active, suggesting that these plants may be used as new sources of natural medicine. Pharmacological activities of the extracts from this plant genus and their active constituents were summarized in Table 3.

Table 3 Pharmacological Activities of Extracts and Active Constituents of *Aglaia* species

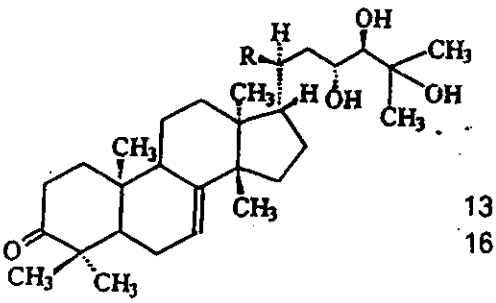
Plant Name	Plant Part	Extracts/ Chemical Constituents	Pharmacological Activity	References
Aglaia argentea	Bark	Ethanol extract	Cytotoxic	Omobuwajo *et al.*,1996a
	Leaf	Ethanol extract	Cytotoxic	Mohamad *et al.*,1997
	Seed	Ethanol extract	Cytotoxic	Omobuwajo *et al.*,1996b
Aglaia duperreana	Leaf	Methanolic extract	Insecticide	Nugroho *et al.*,1997a
Aglaia elaeagnoidea	Stem bark	Dichloromethane extract	Antifungal	Fuzzati *et al.*,1996
Aglaia elliptica	Fruit	Didesmethylrocaglamide (35)	Insecticide	Nugroho *et al.*,1997b
		Rocaglamide (36)	Insecticide	Nugroho *et al.*,1997b
		Rocaglamide derivative (61)	Insecticide	Nugroho *et al.*,1997b
		Rocaglamide derivative (62)	Insecticide	Nugroho *et al.*,1997b
		Rocaglamide derivative (63)	Insecticide	Nugroho *et al.*,1997b
		Rocaglamide derivative (64)	Insecticide	Nugroho *et al.*,1997b
	Stem&Fruit	Methyl rocaglate (88)	Cytotoxic	Cui *et al.*,1997
Aglaia elliptifolia	Root & Stem	Rocaglamide (36)	Antileukemic	King *et al.*,1982
		Dehydrorocaglamide (59)	Antileukemic	King *et al.*,1982

Table 3 Pharmacological Activities of Extracts and Active Constituents of *Aglaia* species

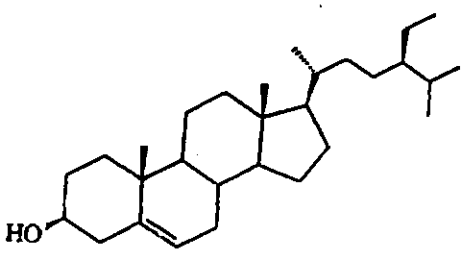
Plant Name	Plant Part	Extracts/ Chemical Constituents	Pharmacological Activity	References
	Stem bark	Aglafolin (60)	Antiplatelet aggregation	Ko *et al.*,1992; Wu *et al.*, 1997
Aglaia formosana	Leaf	Dehydroodorin (6)	Anticancer	Duh *et al.*, 1993
Aglaia harmsiana	Leaf	Didesmethylrocaglamide (35)	Insecticide	Nugroho *et al.*,1997b
		Rocaglamide (36)	Insecticide	Nugroho *et al.*,1997b
		Rocaglamide derivative (61)	Insecticide	Nugroho *et al.*,1997b
		Rocaglamide derivative (62)	Insecticide	Nugroho *et al.*,1997b
		Rocaglamide derivative (63)	Insecticide	Nugroho *et al.*,1997b
		Rocaglamide derivative (64)	Insecticide	Nugroho *et al.*,1997b
Aglaia leucophylla	Stem bark	(+) – Ocotillone (77)	Cytotoxic	Benosman *et al.*,1995
Aglaia odorata	Leaf and Twig	(-) - Odorinol (9)	Antileukemic	Hayashi *et al.*,1982
	Leaf, Twig and Flower	Rocaglamide (36)	Insecticide	Janprasert *et al.*, 1992; Ishibashi *et al.*, 1993; Gussregen *et al.*,1997
	Leaf	Aglaiastatin (90)	Cytotoxic	Onse *et al.*, 1996

Table 3 Pharmacological Activities of Extracts and Active Constituents of *Aglaia* species

Plant Name	Plant Part	Extracts/ Chemical Constituents	Pharmacological Activity	References
		Desmethyl rocaglamide (35)	Insecticide	Ishibashi *et al.*, 1993
		Methyl rocaglate (88)	Insecticide	Ishibashi *et al.*, 1993
		Pyrimidinone (89)	Cytotoxic	Ohse *et al.*, 1996
		Rocaglaol (67)	Cytotoxic , Insecticide	Ishibashi *et al.*, 1993 ; Ohse *et al.*, 1996
Aglaia odoratissima	Plant exudate	–	Cytotoxic	Dhar *et al.*,1973
Aglaia oligophylla	Twig	Rocaglamide (36)	Insecticide	Hwunseng *et al.*,1995
		Desmethyl rocaglamide (35)	Insecticide	Hwunseng *et al.*,1995
Aglaia roxburghiana	Leaf	(+)-Odorinol (9)	Antiviral	Joshi *et al.*,1987
Aglaia pirifera	Leaf	Piriferine (10)	Cytotoxic	Saifah *et al.*,1992



13 R=CH_2OH
16 R=CH_3



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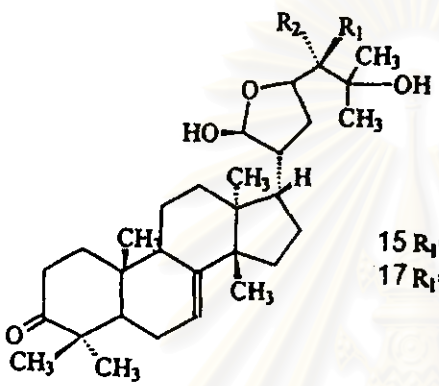
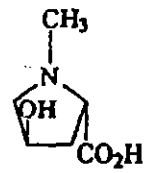


15 R_1=H; R_2=OH
17 R_1=OH; R_2=H



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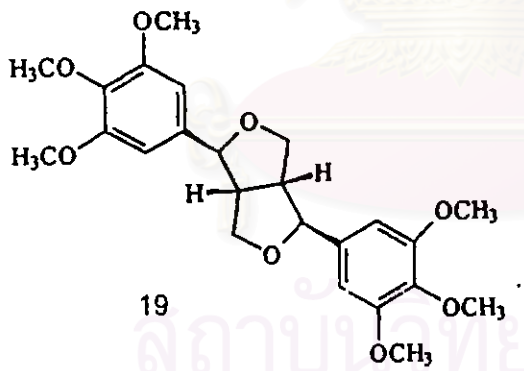

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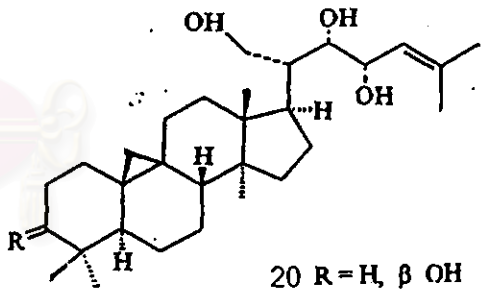
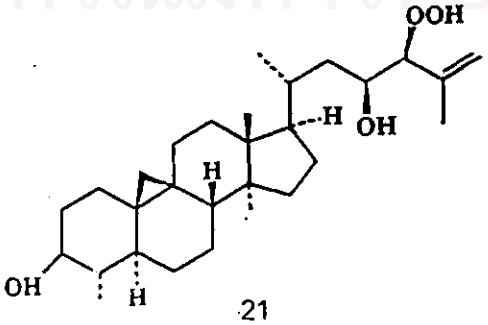


20 R = H, β OH

26 R = O



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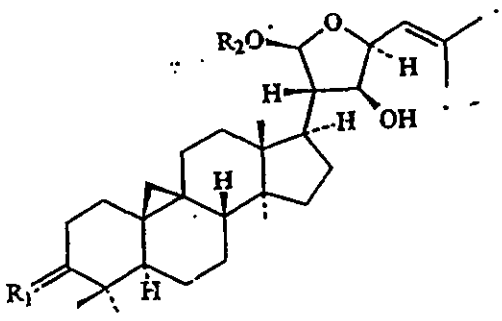
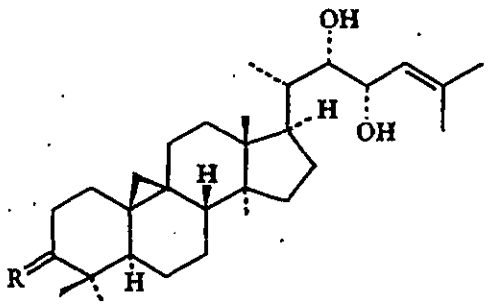


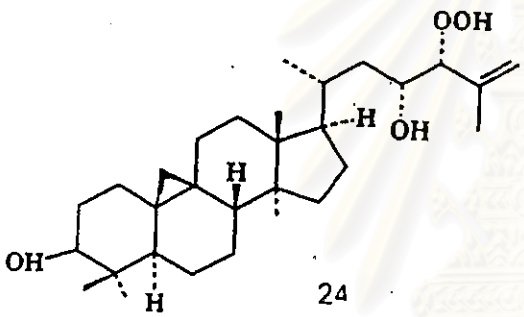
22 R_1 = H, βOH, R2 = H

28 R_1 = O, R_2 = C_2H_5



23 R = H, β OH

27 R = O



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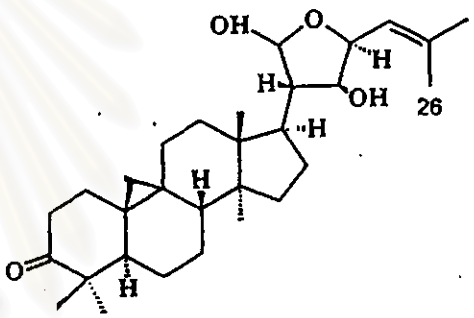

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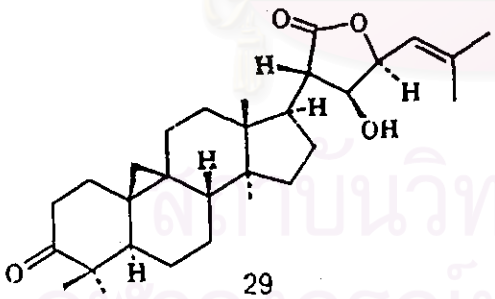

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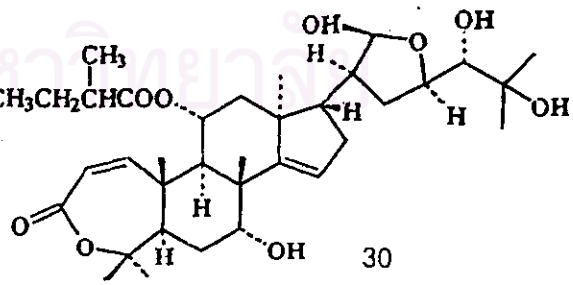

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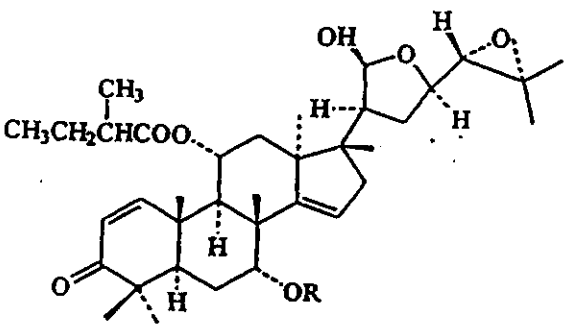
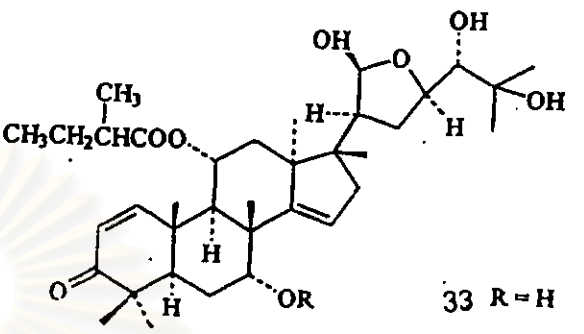


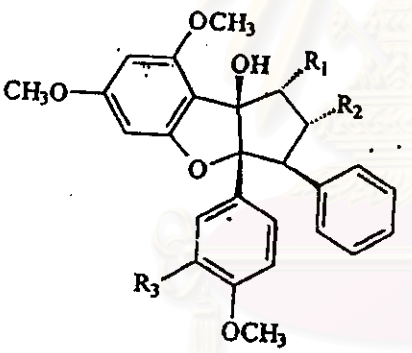
31 R = H

32 R = Ac



33 R = H

34 R = Ac



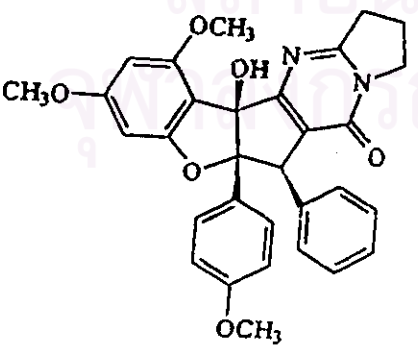
35 R_1 = OH, R_2 = $CONHCH_3$, R_3 = H

36 R_1 = OH, R_2 = $CON(CH_3)_2$, R_3 = H

37 R_1 = OH, R_2 = $CON(CH_3)_2$, R_3 = OH

38 R_1 = OAc, R_2 = $CON(CH_3)_2$, R_3 = OH

39 R_1 = OH, R_2 = $CON(CH_3)_2$, R_3 = OCH_3



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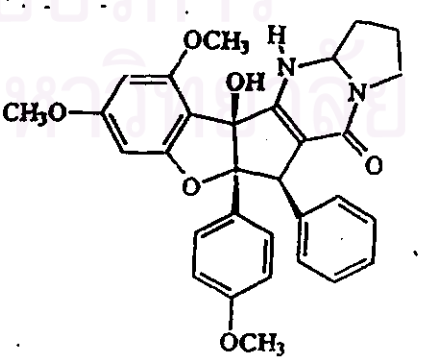

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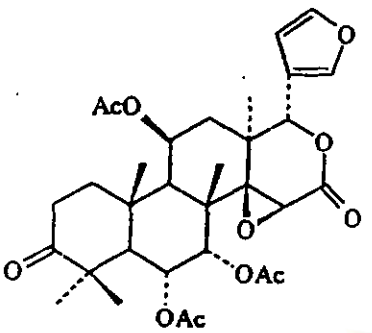

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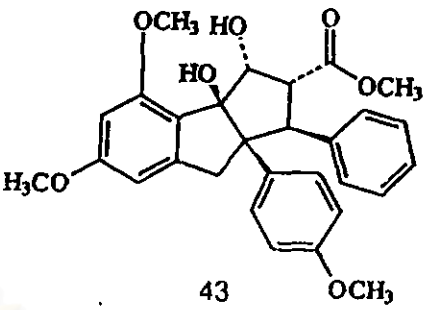

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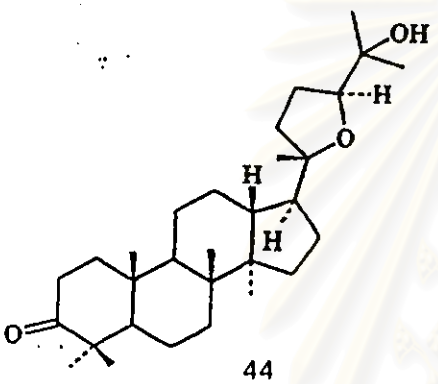

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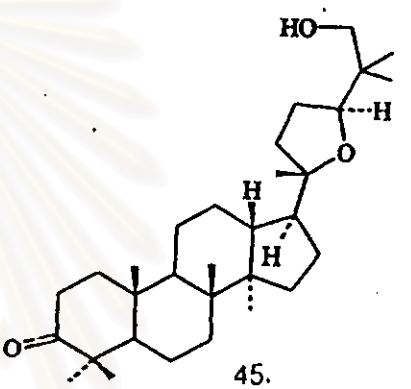

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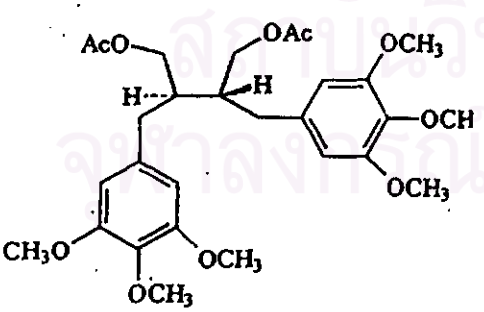

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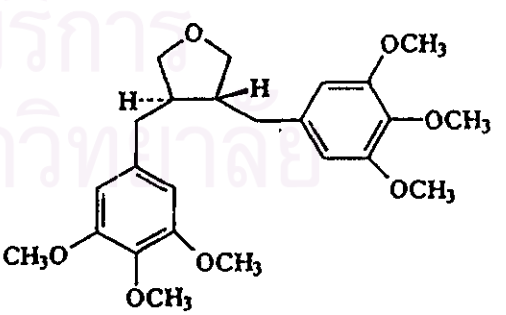

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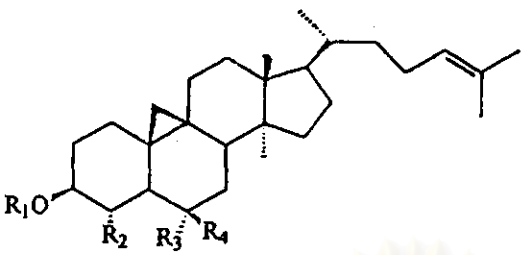
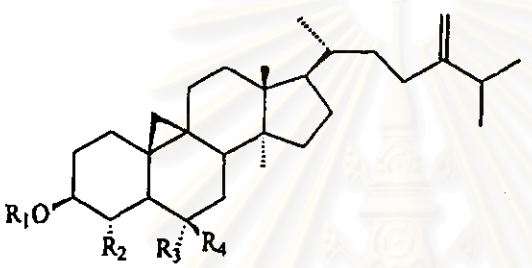


48 $R_1 = R_2 = R_4 = H$, $R_3 = OH$

49 $R_1 = R_4 = H$, $R_2 = R_3 = OH$

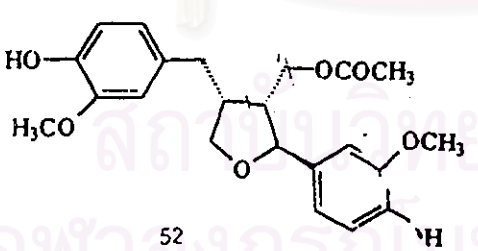
50 $R_1 = R_2 = H$, $R_3/R_4 = O$



51 $R_1 = R_2 = H$, $R_3 / R_4 = O$

53 $R_1 = R_4 = H$, $R_2 = R_3 = OH$

54 $R_1 = R_2 = R_4 = H$, $R_3 = OH$



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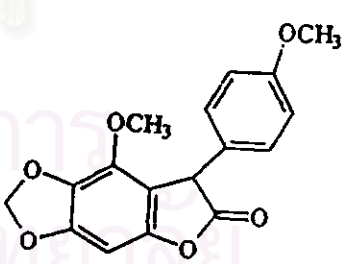

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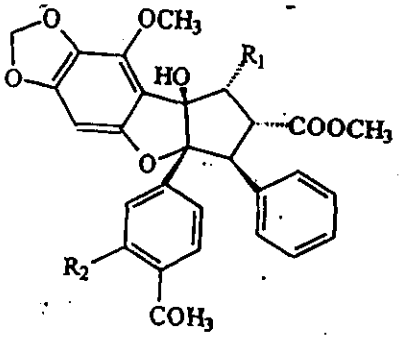
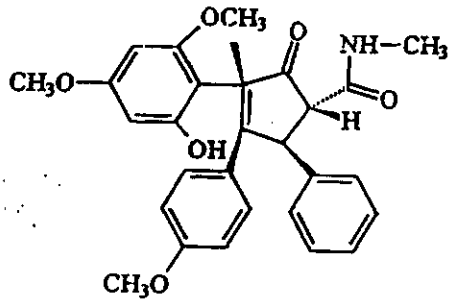


56 $R_1 = OH$, $R_2 = OCH_3$

57 $R_1 = OH$, $R_2 = H$

58 $R_1 = OCOCH_3$, $R_2 = H$



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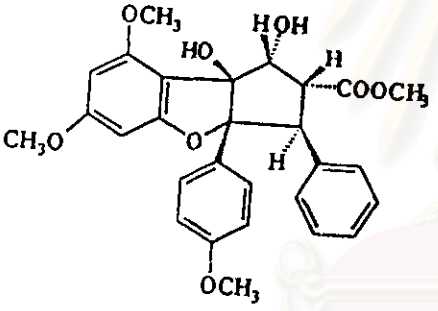

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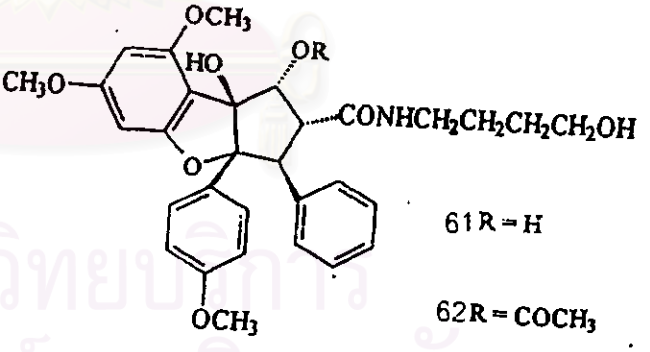
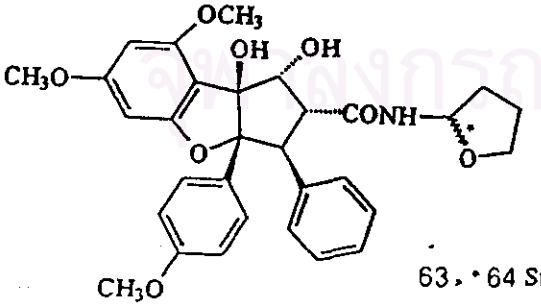
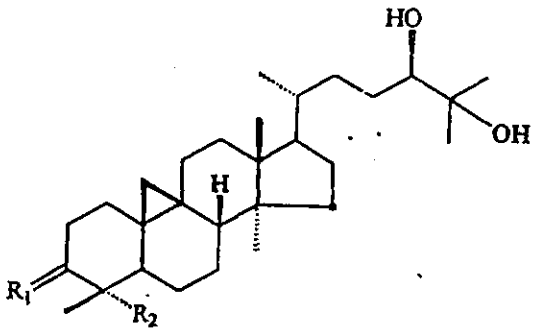


61 R = H

62 R = $COCH_3$



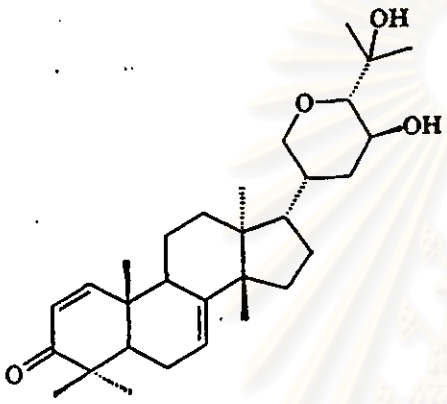
63 , * 64 Stereocentre



74 $R_1 = O$, $R_2 = CH_3$

75 $R_1 = \alpha$ OH, βH; $R_2 = CH_3$

76 $R_1 = \beta$ OH, α H; $R_2 = CH_3$



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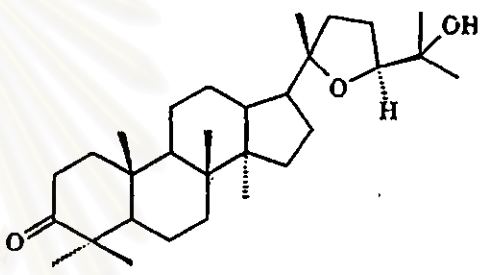

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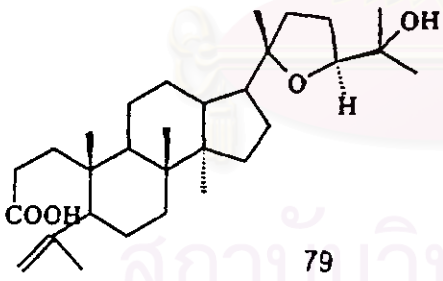

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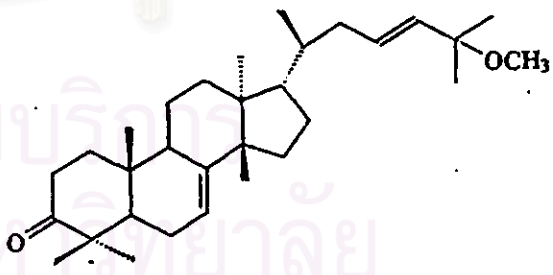

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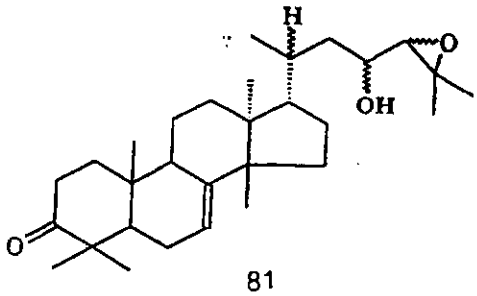

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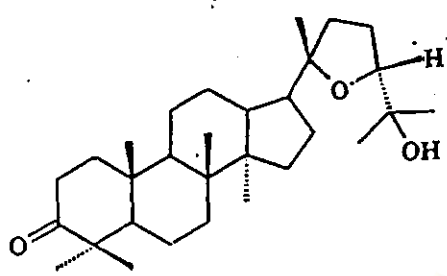

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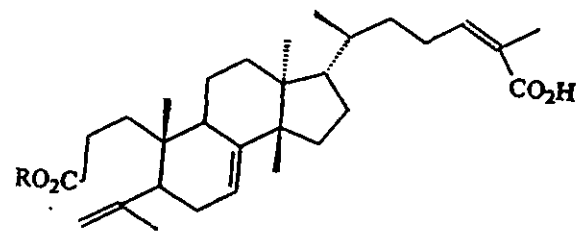
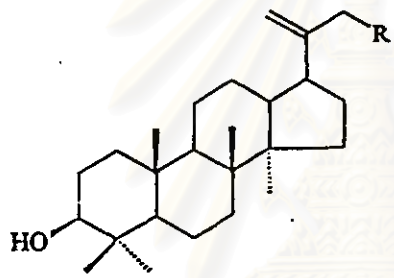
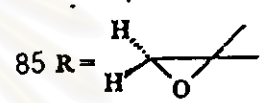


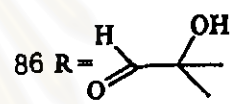
83 R = H

84 R = CH_3

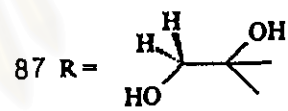




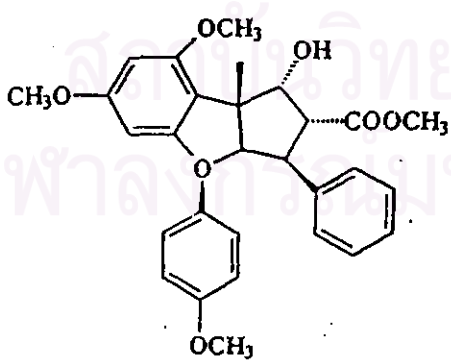
85 R =



86 R =



87 R =



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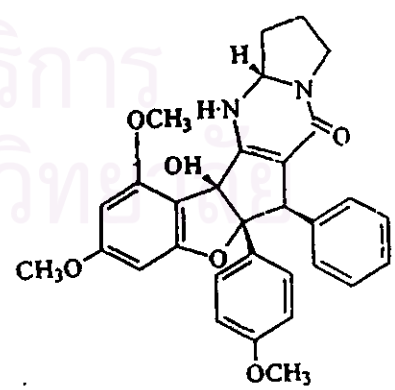

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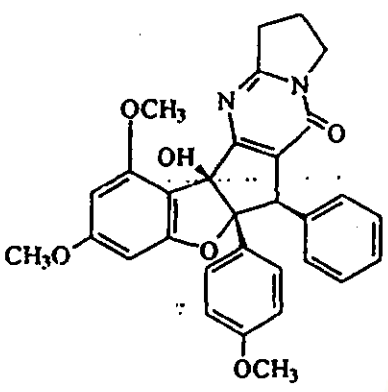

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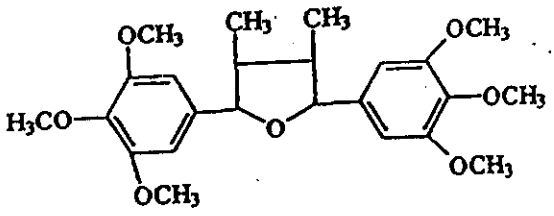

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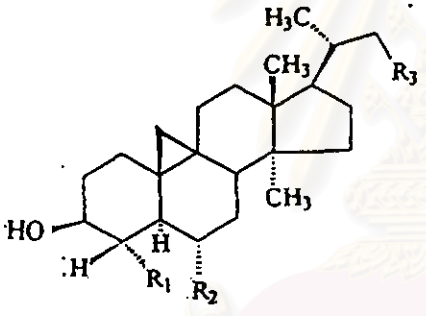
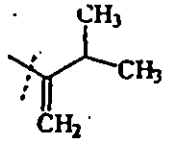
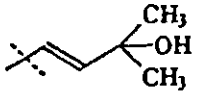
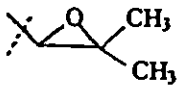
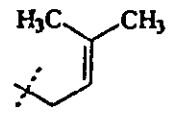
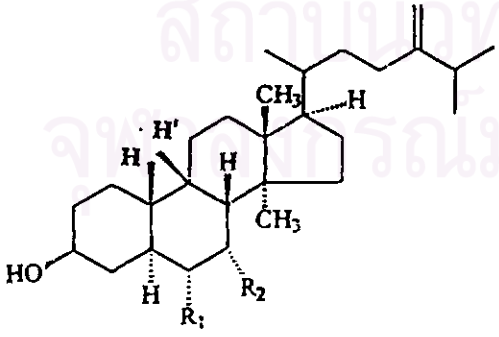


92 R_1 = H; R_2 = OH; R_3 = 

93 R_2 = H; R_1 = CH_3; R_3 = 

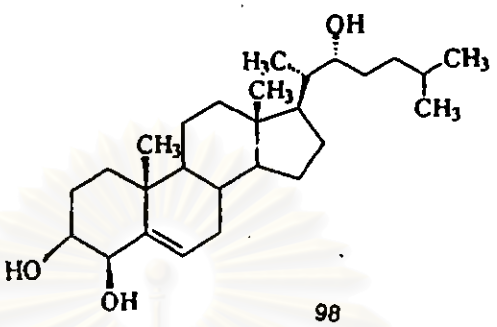
94 R_2 = H; R_1 = CH_3; R_3 = 

95 R_2 = H; R_1 = CH_3; R_3 = 



96 R_1 = H, R_2 = OH

97 R_1 = OH, R_2 = H



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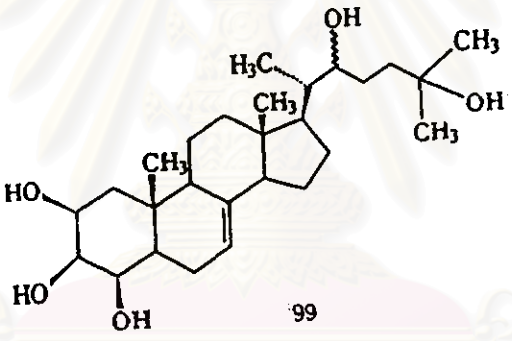
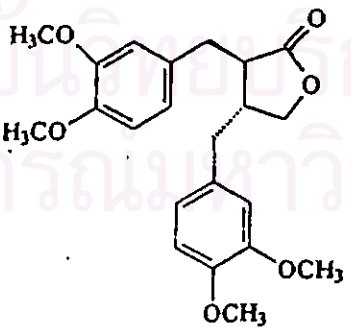


99



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