CHAPTER II

HISTORICAL

1. Bioactive compounds of the Celastraceae

The Celastraceae family is indigenous to tropical and sub-tropical regions of the world , including North Africa , South America , and many parts of East Asia , particularly China.[3,4] The family constitutes approximately 88 genera and 1300 species of plants.[4] They have been valued since antiquity because their extracts have useful medicinal properties.[4,5] Indeed , the variety of properties attributed to crude plant extracts of the Celastraceae in traditional medicine and agriculture is astonishing , and includes stimulant , appetite suppressive , sedative , emetic , purgative , memory-restorative , male contraceptive , anti-tumor , anti-leukemic , anti-bacterial , insecticidal and insect repellant activities.[4] For example , extracts of the root of the thunder-god vine *Tripterygium wilfordii* Hook. f. have been used by the Chinese for centuries to combat life-threatening illness , and have more recently found application in the treatment of leukemia and rheumatoid arthritis.[6] Similarly , the stimulating properties of the leaves of the khat bush *Catha edulis* Forssk. , which grows in certain parts of East Africa and Southern Arabia , were reported in the literature as early as 1237 by the Arabian physician Naguib Ad Din , who proposed the use of khat for alleviating depression. Since khat leaves rapidly lose their effect after picking , the culture of chewing khat leaves for their stimulant/euphoric and appetite/fatigue suppressive effects was for centuries confined to the immediate areas where the plants grows. The habit had become so widespread by the mid-1970s because of the improvements in road communications, a form of addiction known as khatism was beginning to present serious social and economic difficulties in Ethiopia and the Yemen Republic.[4,7] This prompted the World Health Organization to fund an investigation to determine the active constituents of khat. This led to the coincidental discovery of the macrolide maytansine **(1)** from *Maytenus ovatus* Loes. in 1972 , which displayed exceptionally high inhibitory activity *in vitro* against certain human carcinomas[8], that catapulted the natural product chemistry of the Celastraceae into the limelight. The development of maytansine **(1)** and related macrolides as anti-tumor lead has halted in the 1980s when they were found to cause serious gastro-intestinal damage in rats[4], but recent advances in drug targeting *via* conjugation to cancer-specific humanized antibodies appear to offer new opportunities for clinical application.[4]

Over the last 30 years or so, a large number of secondary metabolites exhibiting a wide range of bioactivity have been extracted from the Celastraceae. The maytansinoids, maytansine (**1**), maytanprine (**2**) and maytanbutine (**3**) displayed cytotoxic activity.[9-11] The sesquiterpene pyridine alkaloids triptonine A (**4**) and triptonine B (**5**) isolated from *Tripterygium hypoglaucum* (Levl.) Hutch. and *T. wilfordii* showed anti - HIV activity and were considered a new class of potent anti - HIV agents[12]. Ebenifoline E-11 (**6**) and congorinine E-1 (**7**), two other compounds isolated from *T. wilfordii* Hook. f., possessed immunosuppressive activity[13]. Emarginatine A (**8**)[14], emarginatine F (**9**)[15], and emarginatinine (**10**)[14] from *Maytenus emarginata* and celahinine A (**11**)[16] from *Celastrus hindsii* showed cytotoxic activity whereas cathedulin E-5 (**12**) from *Catha edulis* exhibited potent insecticidal activity.[4]

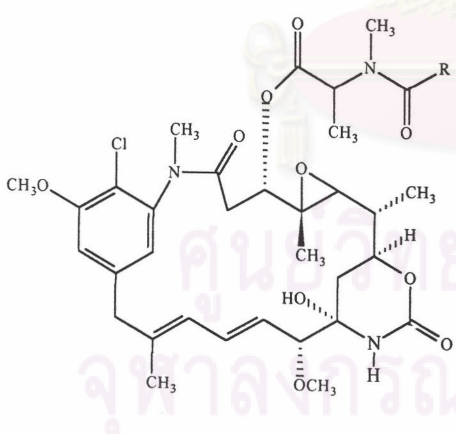
The quinone - methide triterpenes tingenone (**13**), 22β - hydroxy tingenone (**14**), celastrol (**15**), and pristimerin (**16**) displayed cytotoxic activity[17,18-19,20], and several quinone – methide triterpenes have been reported for their antimicrobial activity.[21-26]

The dihydroagarofuran sesquiterpene, celangulin (**17**), showed insecticidal and anti-feedant activity.[27] Both celafolin D-2 (**18**) and celafolin B-2 (**19**) exhibited cytotoxic activity.[28] Interestingly, celafolin A-1 (**20**) and celorbicol (**21**) have also been found to reverse multi-drug resistance (MDR) in cancer cells.[29] More recently, a series of sesquiterpenoids based on 4β,14-dihydroxycelapanol (**22**) and 3,13-dideoxyeuonyminol core structure (**23 and 24**) have been found to reverse the resistance of parasitic protozoan *Leishmania tropica* to growth inhibition by daunomycin.[30]

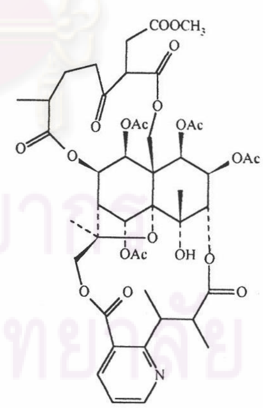
The tri-epoxide diterpenoid triptolide (**25**), isolated from the roots of *Tripterygium wilfordii*, has been shown to be responsible for some of the significant anti-leukemic and anti-tumor activity of this plant. The compound also displayed male anti - fertility property and exhibited more potent anti-inflammatory activity than prednisolone (**26**).[31] It is one of a number of diterpene epoxides contained in a commercially available ' total multi – glycoside extract' or 'T_{II} extract' that has been used clinically for male fertility control, treatment of inflammatory, and autoimmune diseases in China. Triptolide was believed to be the main active principle responsible for the immunosuppressive activity of ' T_{II} extract '.[31]

Three triterpenes from different genera of this plant family , 3-oxo-lup-20(29)-en-30,21α-olide **(27)** , elabunin **(28)** , and maytenfoliol **(29)** were shown to possessed cytotoxic activity. [32-34] Another triterpene , 2α,3β-dihydroxy-olean-12-ene-22,29-lactone **(30)** , possessed immunosuppressive activity [31], while kotalagenin 16-acetate **(31)** were found to have inhibitory activity on enzyme aldose reductase . [35]

Furthermore , a diverse array of bioactive phenyl-alkylamines , and flavonoids have also been isolated from plants of Celastraceae. In particular , the α-aminoketone, (-)-cathinone **(32)** has now been established as the unstable constituent of fresh khat leaves which is primarily responsible for their stimulant and euphoric effects. The compound is structurally related to , and has the same absolute configuration as , (+)-amphetamine **(33)** and (+)-norpseudoephedrine **(34)** but is a more potent stimulant. [7] The flavonoid quercetin **(35)**, which is found in celastraceous plants and a number of other plant families, displays a wide spectrum of anti-oxidant and anti- inflammatory activity as a result of its ability to quench reactive oxygen radicals. [4]



(1) R=CH_3
(2) R= CH_2CH_3
(3) R= $CH_2CH(CH_3)_2$



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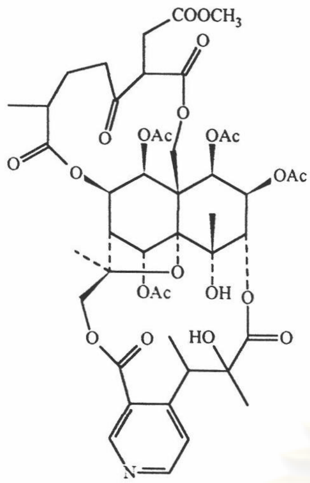

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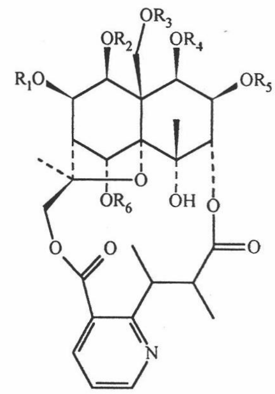
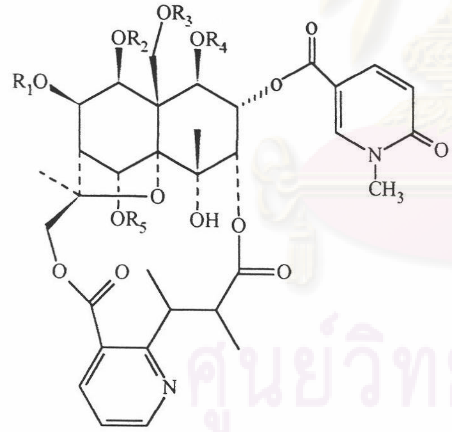
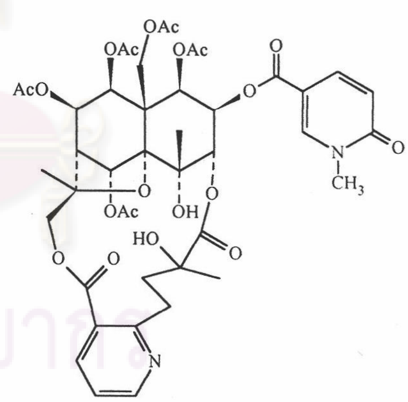


	R_1	R_2	R_3	R_4	R_5	R_6
(6)	Ac	Ac	Ac	Bz	Ac	Bz
(7)	Ac	Ac	Ac	Ac	Ac	Bz
(11)	Ac	Bz	Ac	Bz	Ac	Bz



	R_1	R_2	R_3	R_4	R_5
(8)	Ac	Ac	Ac	Ac	Ac
(9)	H	Ac	Ac	Bz	Ac



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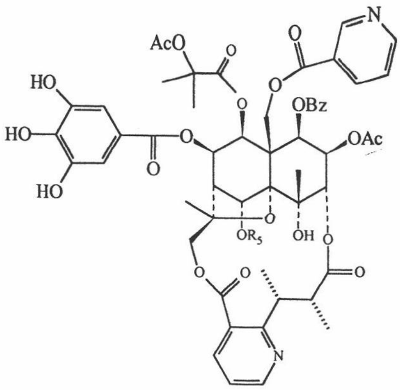

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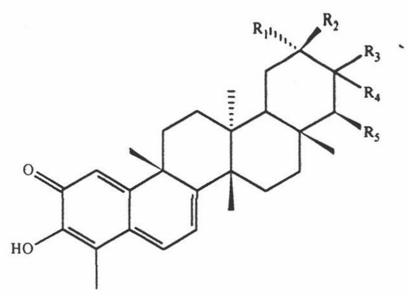
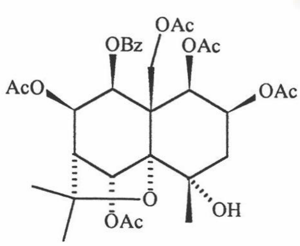


	R_1	R_2	R_3	R_4	R_5
(13)	H	CH_3	=O		H
(14)	H	CH_3	=O		OH
(15)	COOH	CH_3	H	H	H
(16)	$COOCH_3$	CH_3	H	H	H



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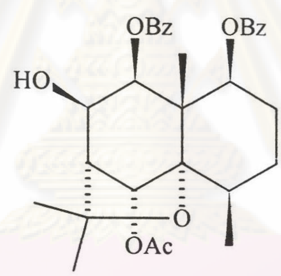

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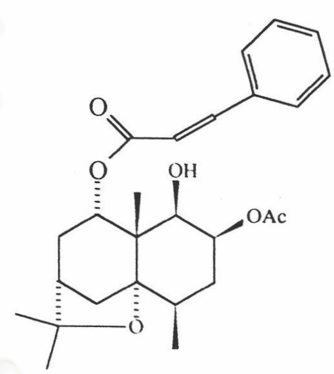

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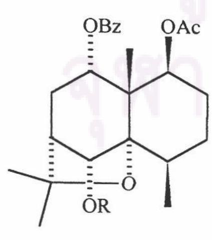
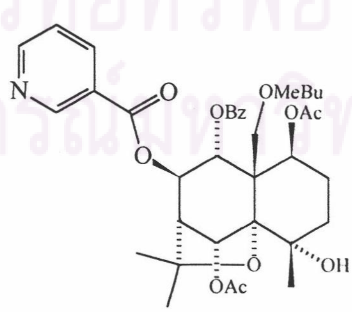
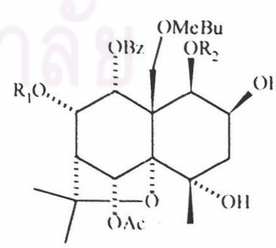




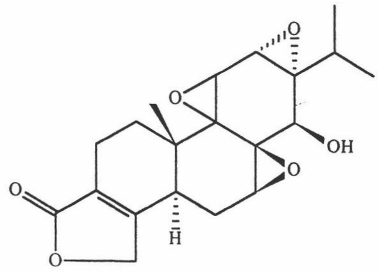


(20) R= Cinnamoyl

(21) R= Bz

(22)

	R_1	R_2
(23)	Ac	Bz
(24)	MeBu	Ac



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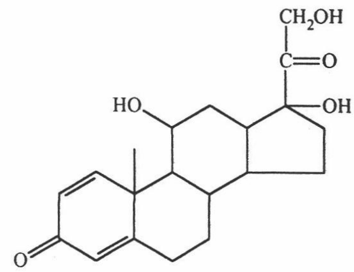

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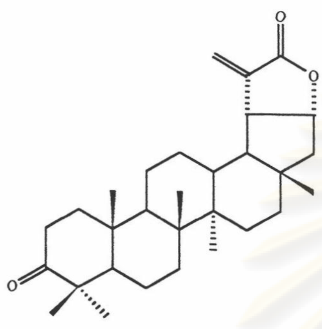

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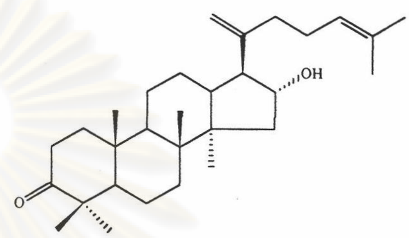

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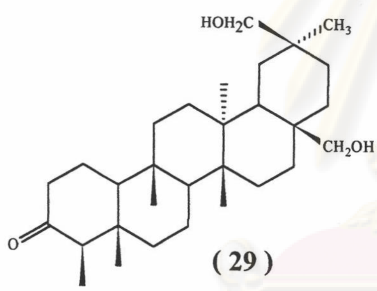

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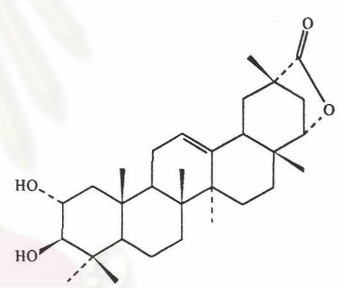

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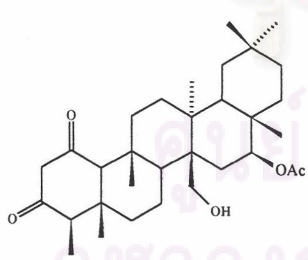

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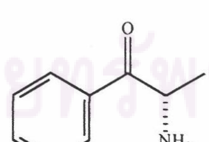
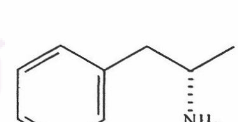


(32)



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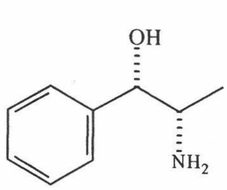

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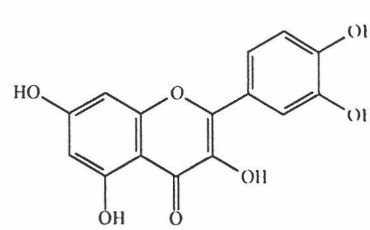


(35)

2. Quinone- methide triterpenes

Quinone-methide triterpenes are the characteristic orange - red pigments of the Celastraceae and Hippocrateaceae. In 1936 , the first quinone – methide triterpene , tripterin (**15**) , was discovered from *Tripterygium wilfordii* Hook. f. [36] and the three year later was again isolated from *Celastrus scandens* Linn., but was called celastrol [37]. In 1951, pristimerin (**16**) , the methyl ester of celastrol , was isolated from *Pristimera indica* (Willd.) A. C. Smith[38]. It took 30 years for the structure determination of the both compound to be completed. [39-40] Their main skeleton is 24-nor-D:A-*friedo*oleanane triterpene with quinone - methide chromophore on ring A / B and hydroxyl group at C-3 position (Figure 2). Up to the year 2002 , one hundred and six quinone - methide triterpenes have been found from nature. This group of compounds can be called celastroloids after the name of the first isolated quinone – methide , celastrol .[41]

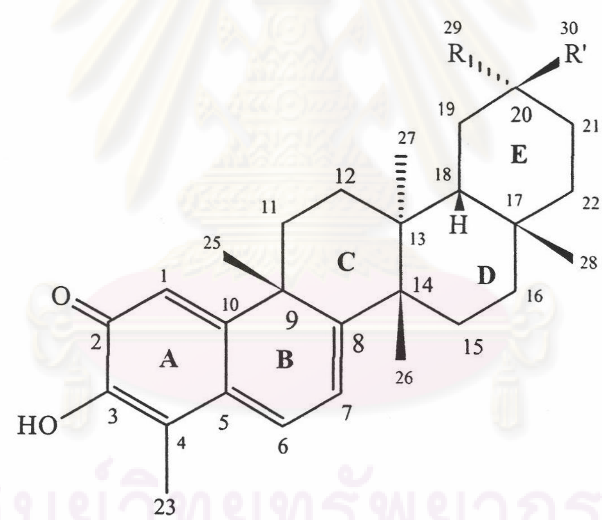


Figure 2. Main skeleton of quinone-methide triterpenes

2.1) Classification of quinone-methide triterpenes

Based on the A / B chromophores, quinone-methide triterpenes can be divided into 3 main classes and 5 subclasses as shown in Table1.

Table 1. Classification of quinone – methide triterpenes based on ring A /B chromophores.

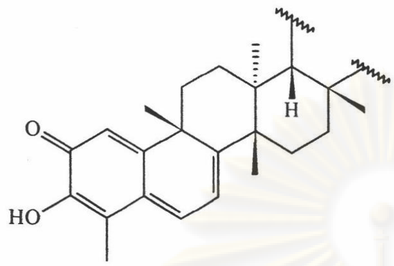
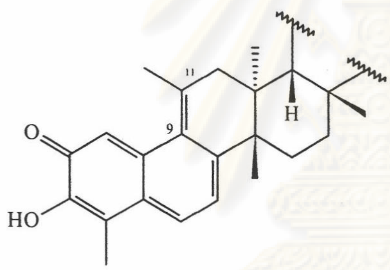
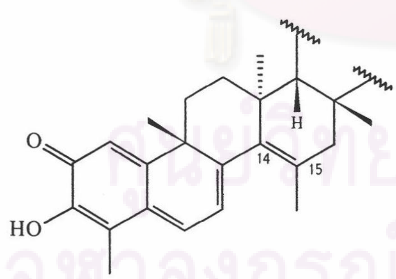
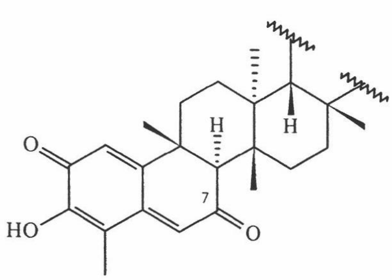
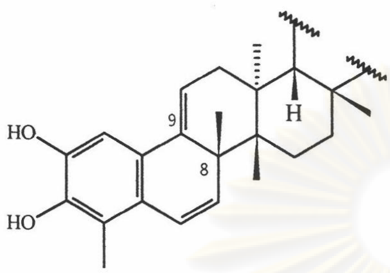
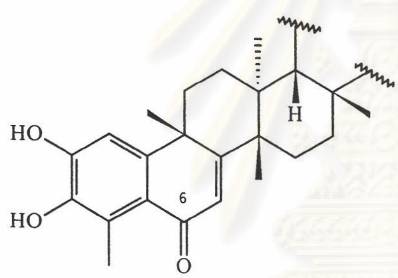
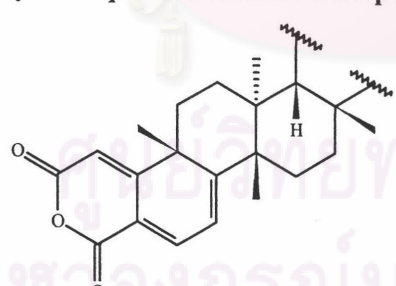
Class/Main Skeleton	Approximated UV λ_{max} (solvent)	Ref.
Class1 Typical quinone-methide triterpenes		
Subclass1.1 Simple quinone-methide triterpenes	421 (MeOH)	17,39
		
Subclass 1.2 Ene-quinone-methide triterpenes		
1.2.1) 9(11)-Ene-(9→11)-quinone-methide triterpenes	446 (MeOH)	39
		
1.2.2) 14(15)-Ene-(14→15))-quinone-methide triterpenes	444 (EtOH)	40
		
Subclass 1.3 7-Oxo-quinone-methide triterpenes	321, 328, 409 (EtOH)	41
		

Table1. (continued)

Class/Main Skeleton	Approximated UV λ_{max} (solvent)	Ref.
Class 2 Phenolic-D:A-*friedo*-24-noroleananes **Subclass 2.1** Phenolic-(9→8)D:A-*friedo*-24-noroleananes 	305, 376 (EtOH)	42
Subclass 2.2 6-Oxo-phenolic-D:A-*friedo*-24-noroleananes 	307 (MeOH)	18
Class 3 Anhydride quinone-methide triterpenes 	392 (EtOH)	43

Natural quinone - methide triterpenes mostly occur as monomers , although dimmers can be found. Nine type of monomeric quinone – methides can be categorized according to the substitution pattern of their E ring and the chromophore character. There are pristimerin, netzahualcoyone, excelsine, tingenone, 21-desoxotingenone, iguesterin, balaenol ,*Salacia* quinone-methide, and celastranhydride types. The dimeric quinone – methides are produced from the linkage of the pristimerin, tingenone or netzahualcoyone type. The linkage can be either one or two ether-linkages. These naturally occurring quinone-methide triterpenes are summarized in Table 2 and 3.

Table 2. Naturally occurring monomeric quinone – methide triterpenes.

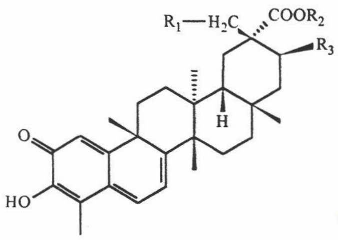
Compound / Structure	Plant source		Reference
1.Pristimerin type			
Pristimerin  (R_1=R_3=H, R_2=CH_3)	*Acanthothamnus aphyllus* T. S. Brandegee	root	44
	Austroplenckia populnea (Reiss.) Lundell	root bark	45
	Cassine balae Kostermans	outer root- bark	40 , 46
	Catha edulis Forssk.	root bark	47-48
	Celastrus paniculatus Willd.	root bark outer root-bark	49 43
	Crossopetalum uragoga O. Ktze.	root	50
	Gymnosporia emarginata (Willd.) Hook. f. ex Thw.	root	51
	Gymnosporia montana (Roth) Benth.	root bark and stem bark	52
	Hippocratea excelsa H. B. et K.	stem bark and root bark	53
	Kokoona reflexa Thw.	outer root-bark	43
	Kokoona zeylanica Thw.	outer stem-bark root bark	54 - 56 55
	Maytenus boaria Molina	root	57
	Maytenus canariensis (Loes.) Kunkel et Sunding	root bark root bark	56 , 58 25 , 57
	Maytenus chuchuhuasca R. Hamet et Colas	stem bark	18 , 59
	Maytenus chuchuhuasca R. Hamet et Colas	bark	60
	Maytanus disperma (F.Muell.) Loes.	outer root-bark	61
	Maytenus horrida Reiss		21 - 22
	Maytenus ilicifolia Mart. ex. Reiss.	root bark root cortex	42 62

Table 2. (continued)

Compound / Structure	Plant source		Reference
Pristimerin (continued)	*Maytenus obtusifolia* Mart.	root	57
	Maytenus scutioides (Griseb.) Lourteig et O'Donell	root bark	26
	Maytenus umbellate (R. Br.) Mabberley	root	63
	Pachystigma canbyi A. Gray	root bark	64
	Plenckia polpunea Reiss.	root	65
	Pleurostylia opposita (Wall. ex Carey) Alston	stem bark	66
	Prionostemma aspera Miers	root bark	39
	Reissantia indica (Halle) Ding Hou	root root bark	38 , 67 68
	Rzedowskia tolantoguensis F. Gonzalez -Medrano	root	21, 69
	Salacia beddomei Gamble	stem bark	70
	Salacia crassifolia G. Don		71
	Salacia macrosperma Wight	root bark	72 - 73
	Salacia reticulata Wight var. *β-diandra*	bark outer stem bark outer root bark	74 75 76
	Salacia sp.	root root bark	77 39
	Schaefferia cuneifolia A. Gray	root	78
	Schaefferia cuneifolia Standley		22
	Zinowiewia costarricensis Lundell	root bark	79
	Zinowiewia integerrima Turcs.	root bark	80
Celastrol (tripterin)	*Catha edulis* Forssk.	root bark	47 - 48
($R_1 = R_2 = R_3 = H$)	*Celastrus paniculatus* Willd.	outer root - bark fresh aril	43 81
	Celastrus scandens Linn.	root bark	37
	Celastrus strigillosus Nakai	root	82
	Hippocratea excelsa H. B. et K.	stem bark and root bark	53
	Kokoona ochracea (Elm.) Mirrill	stem bark	19

Table 2. (continued)

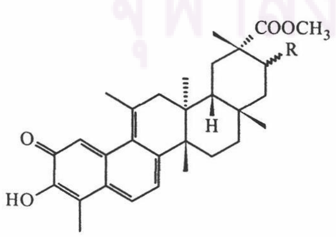
Compound / Structure	Plant source		Reference
Celastrol (continued)	*Kokoona zeylanica* Thw.	outer stem-bark root bark soap cake	55 - 56 55 56
	Maytenus canariensis (Loes.) Kunkel et Sunding	root bark	57
	Maytenus horrida Reiss.		22
	Maytenus scutioides (Griseb.) Lourteig et O' Donell	root bark	26
	Maytenus umbellate (R. Br.) Mabberley	root	63
	Mortonia greggi A. Gray	root	83
	Orthosphenia mexicana Standley	root bark	84
	Salacia reticulata Wight var. β *diandra*	outer root-bark	76
	Schaefferia cuneifolia Standley		22
	Tripterygium wilfordii Hook. f.	root tissue culture crude drug root bark	36 , 85 86 - 89 90 91
	Tripterygium hypoglaucum Hutchinson	root	90
	Tripterygium regelii Sprague et Takeda	root	82 , 92
21-Hydroxypristimerin (R_1= H , R_2= CH_3 , R_3= OH)	*Salacia* sp.	root bark	39
30-Hydroxy-pristimerin (R_1= OH , R_2= CH_3 , R_3= H)	*Salacia reticulata* Wight var. β *diandra*	outer root bark	76
Pristimerinene  (R=H)	*Prionostemma aspera* Miers	root bark	39

Table 2. (continued)

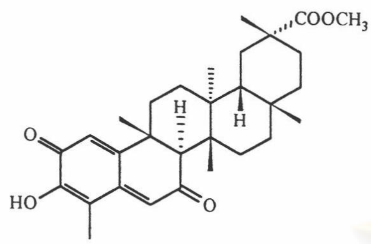
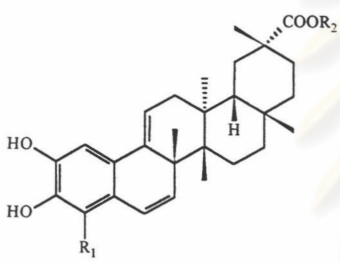
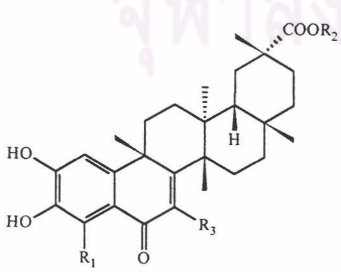
Compound/ Structure	Plant source		Reference
21-Hydroxypristimerinene (R = OH)	*Salacia* sp.	root bark	39
Dispermoquinone	*Austroplenckia populnea* (Reiss). Lundell	root bark	45
	*Austroplenckia populnea* (Reiss). Lundell var. *ovata*	bark wood	93
	Maytenus disperma (F. Muell.) Loes.	outer root- bark	94
Isopristimerin III	*Maytenus ebenifolia* Reiss.		95
 ($R_1 = R_2 = CH_3$)	*Maytenus ilicifolia* Mart.ex Reiss.	root bark	42
23-Oxoisopristimerin III (R_1= CHO, $R_2 = CH_3$)	*Kokoona zeylanica* Thw.	outer stem-bark root bark inner root bark soap cake	55 - 56 55 96 56
Wilforol B ($R_1 = CH_3$, R_2= H)	*Tripterygium wilfordii* Hook. f.	root bark	91
Zeylasterone	*Celastrus paniculatus* Willd.	outer root- bark	43
	*Kokoona reflexa* Thw.	outer root- bark	43
(R_1= COOH , $R_2 = CH_3$, R_3= H)	*Kokoona zeylanica* Thw.	outer stem-bark root bark inner bark	54 - 56 55 97

Table 2. (continued)

Compound / Structure	Plant source		Reference
Zelasteral (R_1= CHO, R_2= CH_3 , R_3= H)	*Celastrus paniculatus* Willd.	outer root- bark	43
	Kokoona reflexa Thw.	outer root- bark	43
	Kokoona zeylanica Thw.	outer stem-bark root bark soap cake	55-56 , 98 55 56
Desmethylzeylasterone (R_1= COOH , R_2= H , R_3= H)	*Kokoona zeylanica* Thw.	outer stem-bark root bark	55-56 , 98 55
	Tripterygium wilfordii Hook. f.	root bark	91
Desmetylzeylasteral (R_1= CHO, R_2= H , R_3= H)	*Kokoona zeylanica* Thw.	outer stem-bark root bark outer root-bark	55 55 56 , 99
	Tripterygium wilfordii Hook. f.	root bark	91
Wilforol A (R_1= CH_3 , R_2=H , R_3= H)	*Tripterygium wilfordii* Hook. f.	root bark	91
6-Oxopristimerol (R_1= R_2 = CH_3 , R_3 = H)	*Maytenus canariensis* (Loes.) Kunkel et Sunding	root bark	25
	Maytenus chuchuhuasca R. Hamet et Colas	stem bark	18
23-Nor-6-oxopristimerol (R_1= H , R_2= CH_3 , R_3 = H)	*Kokoona zeylanica* Thw.	outer root-bark	99
23-Nor-6-oxodesmethyl-pristimerol	*Kokoona zeylanica* Thw.	outer stem-bark root bark outer root-bark	55 55 99
	Tripterygium wilfordii Hook. f.	root bark	91

Table 2. (continued)

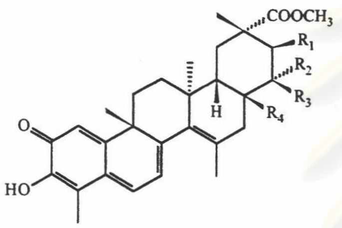
Compound / Structure	Plant source		Reference
2,3,7-Trihydroxy-6-oxo-1,3,5(10),7-tetraene-24-nor-friedelane-29-oic acid methylester (R_1= CH_3 , R_2= CH_3 , R_3= OH)	*Crossopetalum gaumeri* (Loes.)	root	100
2. Netzahualcoyone type			
Netzahualcoyone	*Maytenus horrida* Reiss.		21 - 22
	*Orthosphenia mexicana* Standley		101
		root bark	102
	Rzedowskia tolantoguensis F. Gonzalez -Medrano	root	69 21
(R_1= OH, R_2R_3= O , R_4 = CH_3)	*Schaefferia cuneifolia* Standley		22
Netzahualcoyondiol	*Maytenus horrida* Reiss.		21
(R_1= OH , R_2= H , R_3= OH , R_4= CH_3)	*Orthosphenia mexicana* Standley		101
	Rzedowskia tolantoguensis F. Gonzalez -Medrano	root	69 21
Netzahualcoyonol	*Maytenus horrida* Reiss		21-22
(R_1= OH , R_2= R_3= H, R_4= CH_3)	*Orthosphenia mexicana* Standley		101
	Rzedowskia tolantoguensis F. Gonzalez -Medrano	root	69 21
	Schaefferia cuneifolia Standley		22
Netzahualcoyene (R_1= R_2= R_3= H , R_4= CH_3)	*Maytenus horrida* Reiss		21-22, 101
	Maytenus scutioides (Griseb.) Lourteig et O'Donell	root bark	26
	Rzedowskia tolantoguensis F. Gonzalez -Medrano		21
	Salacia reticulata Wight var. *β-diandra*	outer root- bark	76
	Schaefferia cuneifolia Standley		22

Table 2. (continued)

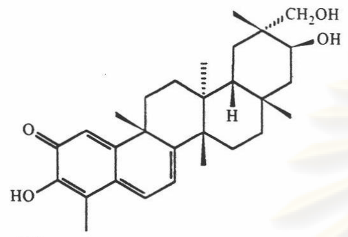
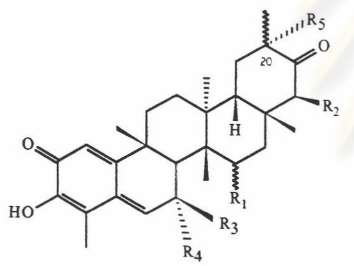
Compound / Structure	Plant source		Reference
Netzahualcoyol (R_1= OH , R_2= R_3= H , R_4= $COOCH_3$)	*Orthosphenia mexicana* Standley		101
3. Excelsine type Excelsine	*Hippocratea excelsa* H. B. et K.	stem bark and root bark	53
			
4. Tingenone type Tingenone (tingenin A , maitenin)	*Acanthothamnus aphyllus* T.S.Brandegee	root	44
	*Cassine balae* Kostermans	outer root bark	40 , 46
	Cassine papillosa (Hochst.) Kuntze	stem bark	103
	Maytenus canariensis (Loes.) Kunkel et Sunding	root bark	57
	Catha edulis Forssk.	root root bark	47 48
(20β-CH_3 , R_1= R_2= H , 7,8-dehydro , R_5= H)	*Crossopetalum uragoga* O. Ktze.	root bark and root medulla	50
	Euonymus tingens Wall.	stem bark stem bark	104 105
	Gymnosporia emarginata (Willd.) Hook. f. ex Thw.	root	51
	Gymnosporia montana (Roth) Benth.	stem bark and root bark	52 , 106
	Hippocratea excelsa H. B. et K.	stem bark and root bark	53
	Kokoona ochracea (Elm.) Mirrill	stem bark	19
	Maytenus buchananii (Loes.) R. Wilczek	tissue culture	20
	Maytenus canariensis (Loes.) Kunkel et Sunding	root bark	25 , 58
	Maytenus chuchuhuasca R. Hamet et Colas	stem bark	18 , 59

Table 2. (continued)

Compound / Structure	Plant source		Reference
Tingenone (continued)	*Maytenus chuchuhuasca* R. Hamet et Colas	bark	60
	Maytenus horrida Reiss.		21 , 22
	Maytenus ilicifolia Mart. ex Reiss.		107
		root cortex	62
		bark	108
	Maytenus laevis Reiss.	root bark	109
	Maytenus obtusifolia Mart.	root	57
	Maytenus scutioides (Griseb.) Lourteig et O'Donell	root bark	26
	Maytenus sp.		110
	Maytenus umbellate (R. Br.) Mabberley	root	63
	Maytenus wallichiana (Spreng ex Wight et Arn.) Raju et Babu	tissue culture	111 - 112
	Plenckia polpunea Reiss.	root	65
	Prionostemma aspera Miers	root bark	39
	Reissantia indica (Halle) Ding Hou	root bark	68
	Rzedowskia tolantoguensis F. Gonzalez - Medrano	root	69
	Rzedowskia tolantoguensis F. Gonzalez - Medrano		21
	Salacia macrosperma Wight	root bark	72 - 73
	Salacia reticulata Wight var.*β-diandra*	outer root bark	76
	Salacia sp.	root bark	39
		root	77
	Schaefferia cuneifolia A. Gray	root	78
	Schaefferia cuneifolia Standley		22
	Tripterygium wilfordii Hook. f.	tissue culture	87 - 89
	Zinowiewia costarricensis Lundell.	root bark	79

Table 2. (continued)

Compound / Structure	Plant source		Reference
3,20α-Dihydroxy-24,29-dinor-1(10),3,5,7-friedelatetraene-2,21-dione (20β - CH_3 , R_1= R_2= H , 7,8-dehydro, R_5= OH)	*Glyptopetalum sclerocarpum* Laws.	stem bark	113
3,20α-,22β-Trihydroxy-24,29-dinor-1(10),3,5,7-frie delatetra ene-2,21-dione (20β - CH_3 , R_1= H , R_2= OH, 7,8-dehydro, R_5= OH)	*Glyptopetalum sclerocarpum* Laws.	stem bark	113
3,20β,22 β-Trihydroxy-24,30-dinor-1(10),3,5,7-friedelatetraene-2,21-dione (20β - OH, R_1=H , R_2= OH , 7,8-dehydro, R_5= CH_3)	*Glyptopetalum sclerocarpum* Laws.	stem bark	113
3,20α-Dihydroxy-24,29-dinor-1(10),3,5,7- friedelatetraene-2,21,22-trione (20β - CH_3 , R_1= H , R_2= O, 7,8-dehydro , R_5= OH)	*Glyptopetalum sclerocarpum* Laws.	stem bark	113
3,20β-Dihydroxy-24,30-dinor-1(10),3,5,7- friedelatetraene-2,21,22-trione (20β - OH , R_1=H , R_2= O, 7,8-dehydro , R_5= CH_3)	*Glyptopetalum sclerocarpum* Laws.	stem bark	113
7,8-Dihydro-7-oxo-22-β-hydroxytingenone (20β - CH_3 , R_1= H, R_2= OH , R_3= R_4= O, R_5= H)	*Maytenus amazonica* C. Martius	root bark	114
7,8-Dihydro-22-β-hydroxy-tingenone (20β - CH_3 , R_1= H , R_2= OH , R_3= R_4= R_5= H)	*Maytenus amazonica* C. Martius	root bark	114
(8S)-7,8-Dihydro-7-oxo-tingenone (20β - CH_3 , R_1 = R_2= H , R_3= R_4= O , R_5= H)	*Maytenus amazonica* C. Martius	root bark	115
(7S,8S)-7-Hydroxy-7,8-dihydro-tingenone (20β - CH_3 , R_1 = R_2 = R_3 = H , R_4= OH , R_5 = H)	*Maytenus amazonica* C. Martius	root bark	115

Table 2. (continued)

Compound / Structure	Plant source		Reference
Tingenin B (22β-hydroxy-tingenone) (20β - CH_3 , R_1= H , R_2= OH , 7,8 - dehydro , R_5= H)	*Acanthothamnus aphyllus* T. S. Brandegee	root	44
	Cassine balae Kostermans	outer root- bark	40 , 46
	Cassine papillosa (Hochst.) Kuntze	stem bark	103
	Catha edulis Forssk.	root bark	47 - 48
	Euonymus tingens Wall.	stem bark	104
	Glyptopetalum sclerocarpum Laws.	stem bark	17
	Maytenus buchananii (Loes.) R.Wilczek	tissue culture	20
	Maytenus canariensis (Loes.) Kunkel et Sunding	root bark	25
	Maytenus chuchuhuasca R. Hamet et Colas	stem bark bark	18 60
	Maytenus laevis Reiss.	root bark	109
	Maytenus obtusifolia Mart.	root	57
	Maytenus sp.		110
	Salacia reticulata Wight var. *β-diandra*	outer root bark	76
	Tripterygium wilfordii Hook. f.	tissue culture	89
15α,22β-Dihydroxytingenone (20β - CH_3 , R_1 = R_2= OH , 7,8 – dehydro , R_5= H)	*Cassine balae* Kostermans	outer root - bark	46
20-Hydroxy-20-epi-tingenone (20β - OH , R_1= R_2=H , 7,8-dehydro , R_5= CH_3)	*Austroplenckia populnea* (Reiss.) Lundell	root bark	45
	Cassine balae Kostermans	outer root - bark	40 - 46
	Euonymus tingens Wall.	bark	105
	Glyptopetalum sclerocarpum Laws	stem bark	116
	Kokoona ochracea (Elm.) Mirrill	stem bark	19
	Rzedowskia tolantoguensis F. Gonzalez-Medrano	root	69
	Salacia macrosperma Wight	root bark	72 - 73

Table 2. (continued)

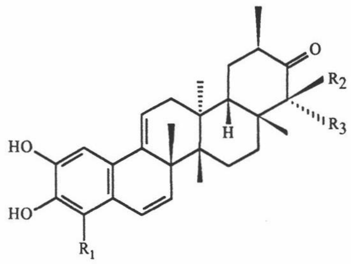
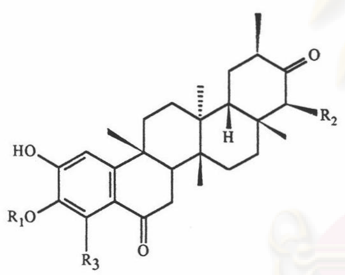
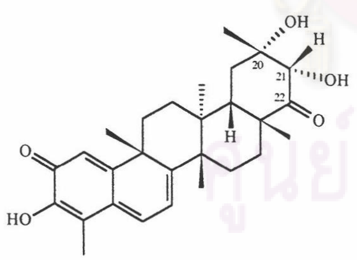
Compound / Structure	Plant source		Reference
Isotingenone III (R_1= CH_3 , R_2= R_3= H) 	*Maytenus ebenifolia* Reiss.		95
	Maytenus ilicifolia Mart. ex Reiss.	root bark	42
23-Oxo-isotingenone (R_1= CHO , R_2= R_3= H)	*Maytenus amazonica* C. Martius	root bark	115
2,3,22β-trihydroxy-24,29-dinor-25(9→8)-1,3,5(10),7-friedelatetraene-21-one-23-al (R_1= CHO , R_2= OH , R_3= H)	*Maytenus amazonica* C. Martius	root bark	114
6-Oxotingenol  (R_1 = R_2= H , R_3 = CH_3)	*Maytenus canariensis* (Loes.) Kunkel et Sunding	root bark	25
	Maytenus ilicifolia Mart. ex Reiss.	root bark	18
(8*S*)-7,8-Dihydro-6-oxo-tingenol (R_1= R_2 = H , R_3= CH_3)	*Maytenus amazonica* C. Martius	root bark	115
23-*Nor*-6-oxo-tingenol (R_1= R_2= H , R_3= H, 7,8-dehydro)	*Maytenus amazonica* C. Martius	root bark	115
2,3,22β-Trihydroxy-24,29-dinor-1,3,5(10),7-friedelatetra ene-6,21-dione-23-al (R_1= H , R_2= OH , R_3 = CHO , 7,8-dehydro)	*Maytenus amazonica* C. Martius	root bark	114
22β-Hydroxy-6-oxo-tingenol (R_1= H , R_2= OH , R_3= CH_3 , 7,8 - dehydro)	*Maytenus amazonica* C. Martius	root bark	114

Table 2. (continued)

Compound / Structure	Plant source		Reference
23-Nor-22-hydroxy-6-oxo-tingenol (R_1= H , R_2= OH , R_3= H , 7,8-dehydro)	*Maytenus amazonica* C. Martius	root bark	114
3-Methoxy-22β-hydroxy-6-oxo-tingenol (R_1= CH_3 , R_2= OH , R_3= CH_3 , 7,8-dehydro)	*Maytenus amazonica* C. Martius	root bark	114
22β-Hydroxy-7,8-dihydro-6-oxo-tingenol (R_1= H , R_2= OH , R_3= CH_3)	*Maytenus amazonica* C. Martius	root bark	114
3-Methyl-6-oxotingenol (R_1= CH_3 , R_2= H , R_3= CH_3)	*Maytenus canariensis* (Loes.) Kunkel et Sunding	root bark	25
	Maytenus chuchuhuasca R. Hamet et Colas	stem bark	95 18
3-Methyl-22β.23-dihydroxy-6-oxotingenol (R_1= CH_3 , R_2 = OH , R_3 = CH_3)	*Maytenus chuchuhuasca* R. Hamet et Colas	stem bark	18
5. 21-desoxotingenone type			
3,20α,21α-Trihydroxy-24,29-dinor-1(10),3,5,7-friedelatetraene-2,22-dione	*Glyptopetalum sclerocarpum* Laws.	stem bark	113



30(20→21)*abeo* -3,21α-Dihydroxy-24,29-dinor-1(10),3,5,7-friedelatetra ene-2,20,22-trione	*Glyptopetalum sclerocarpum* Laws.	stem bark	113

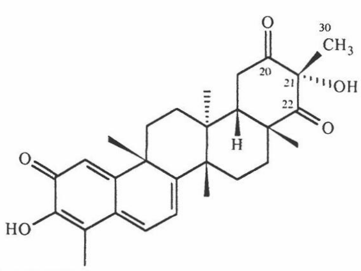


Table 2. (continued)

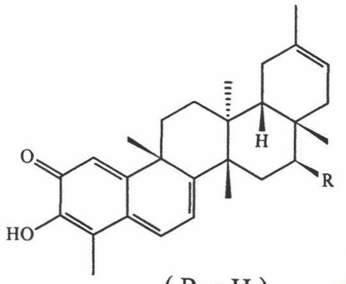
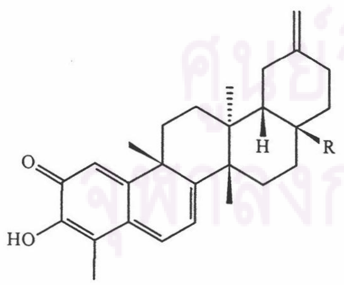
Compound / Structure	Plant source		Reference
6. Iguesterin type			
Iguesterin	*Catha edulis* Forsk	root bark	47 - 48
 (R = H)	*Gymnosporia emarginata* (Willd.) Hook. f. ex Thw.	root	51
	Gymnosporia montana (Roth) Benth.	stem bark and root bark	52
	Maytenus canariensis (Loes.) Kunkel et Sunding	root bark	25, 56-58
	Maytenus horrida Reiss.		21
	Maytenus umbellata (R. Br.) Mabberly	root	63
	Rzedowskia tolantoguensis F. Gonzalez -Medrano		21
	Salacia reticulata Wight var. *β-diandra*	bark	74
16β-Hydroxyiguesterin (R = OH)	*Maytenus canariensis* (Loes.) Kunkel et Sunding	root bark	117
Isoiguesterin	*Salacia madagascariensis* DC.	root	118
 (R = CH_3)	*Salacia reticulata* Wight var.*β-diandra*	root bark outer root - bark	41 76
28-*Nor*-isoiguesterin-17-carbaldehyde (R = CHO)	*Salacia kraussii* (Harv.)	root	119

Table 2. (continued)

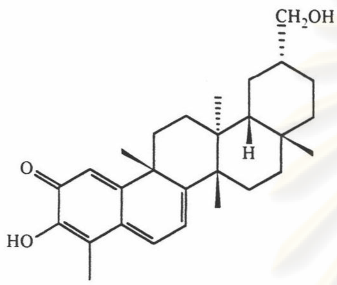
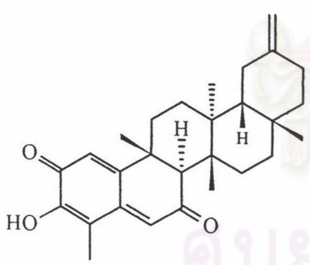
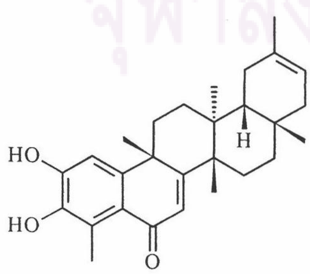
Compound/ Structure	Plant source		Reference
17-(Methoxycarbonyl)-28-*nor*-isoiguesterin (R = COOMe)	*Salacia kraussii* (Harv.)	root	119
28-Hydroxyisoiguesterin (R = CH_2OH)	*Salacia kraussii* (Harv.)	root	119
Isoiguesterinol	*Salacia reticulata* Wight var.β-*diandra*	outer root - bark	76
			
(R = CH_2OH)			
Salaciquinone	*Salacia reticulata* Wight var.β-*diandra*	root bark outer root - bark	41 76
			
6-Oxo-iguesterol	*Maytenus canariensis* (Loes.) Kunkel et Sunding	root bark	25
			

Table 2. (continued)

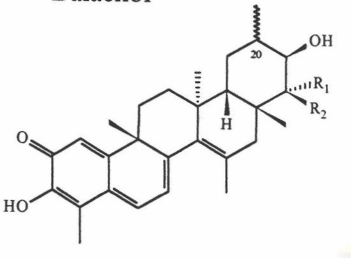
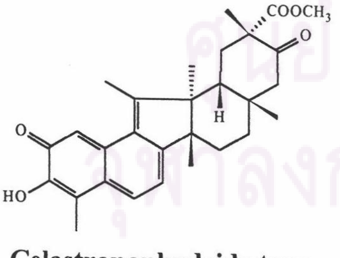
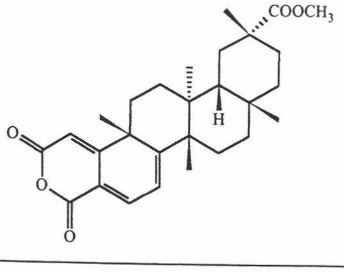
Compound / Structure	Plant source		Reference
7. Balaenol type			
Balaenol  (20β - CH_3, R_1= R_2= H)	*Cassine balae* Kostermans	outer root-bark	40 , 46 , 120
Balaenonol (20β - CH_3 , R_1 R_2= O)	*Cassine balae* Kostermans	outer root-bark	40 , 46 , 120
Isobalaenol (20α - CH_3 , R_1= R_2= H)	*Cassine balae* Kostermans	outer root-bark	46
Isobalaendiol (20α -CH_3 , R_1 = H , R_2= OH)	*Cassine balae* Kostermans	outer root-bark	40 , 46
8. Salacia quinonemethide type 	*Salacia macrosperma* Wight	root bark	72 - 73
9. Celastrananhydride type			
Celastranhydride 	*Cassine balae* Kostermans	outer root bark	43
	Kokoona reflexa Thw.	outer root bark	43
	Kokoona zeylanica Thw.	outer root bark	43
	Reissantia indica (Halle) Ding Hou	outer root bark	43

Table3. Naturally occurring dimeric quinone – methide triterpenes.

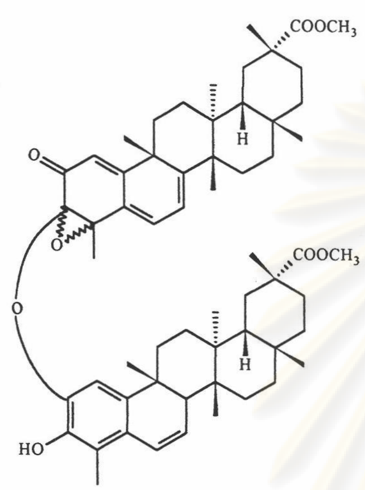
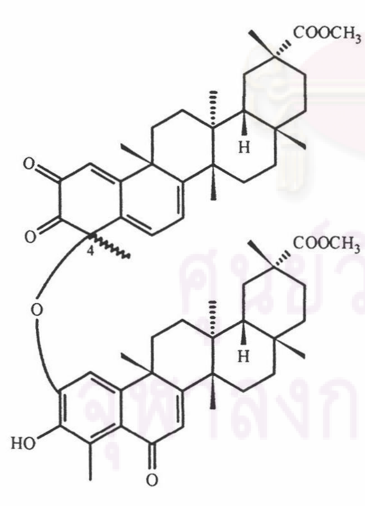
Compound/Structure	Plant source	Reference
1. One - ether linkage dimers		
1.1) Pristimerin-pristimerin type		
Magellanin	*Maytenus magellanica* Hook.f.	121
		
Rzedowskia bistriterpenoid	*Rzedowskia tolantoguensis* F. Gonzalez - Medrano root	122
		
(4α-CH_3)		
4-Epimeric Rzedowskia bistriterpenoid (4β-CH_3)	*Rzedowskia tolantoguensis* F. Gonzalez - Medrano root	122

Table3. (continued)

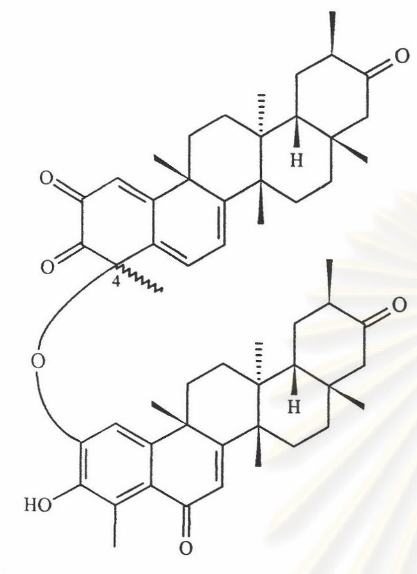
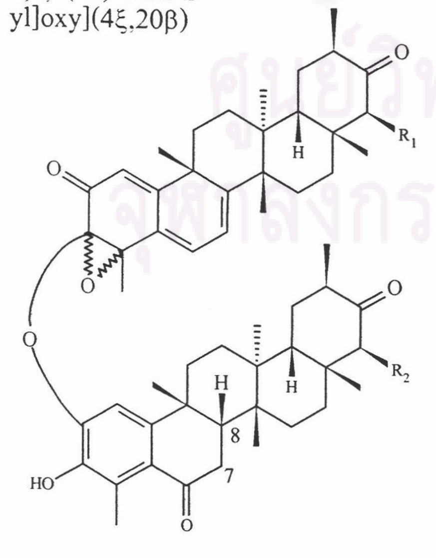
Compound/Structure	Plant source	Reference
1.2) Tingenone - tingenone type		
Umbellatin α  (4α - CH_3)	*Maytenus umbellata* (R. Br.) Mabberley root	24
Umbellatin β (4β - CH_3)	*Maytenus umbellata* (R. Br.) Mabberley root	24
D:A-*Friedo*-24,30-dinor-oleana-1(10),5,7-triene-2,21-dione,3,4-epoxy-3-[[(8β,20β)-3-hydroxy-6,21-dioxo-D:A-*friedo*-24,30-dinoroleana-1,3,5(10)-trien-2-yl]oxy](4ξ,20β)  (R_1= R_2= H)	*Maytenus chuchuhuasca* R. Hamet et Colas	95

Table3. (continued)

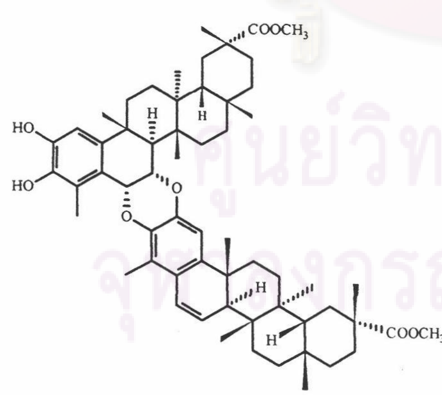
Compound/Structure	Plant source		Reference
D:A-*Friedo*-24,30-dinor-oleana-1,3,5(10),7-tetraene-6,21-dione ,2 [[4ξ ,20β)-3,4-epoxy-2,21-dioxo- D:A-*friedo*-24,30-dinoroleana-1(10),5,7-trien-3-yl]oxy]-3-hydroxy (20β) (R_1= R_2= H, 7,8 - dehydro)	*Maytenus chuchuhuasca* R. Hamet et Colas		95
D:A-*Friedo*-24,30-dinor-oleana-1,3,5(10),7-tetraene-6,21-dione,2[[4ξ ,20β.22β)-3,4-epoxy-22-hydroxy-2,21-dioxo-D:A-*friedo*-24,30-dinoroleana-1(10),5,7-trien-3-yl]oxy]-3,22-dihydroxy (20β.22 β) (R_1= H , R_2= OH, 7,8 - dehydro)	*Maytenus chuchuhuasca* R. Hamet et Colas		95
D:A-*Friedo*-24,30-dinor-oleana-1,3,5(10),7-tetraene-6,21-dione,2[[4ξ, 20β.22β)-3,4-epoxy-22-hydroxy-2,21-dioxo-D:A-*friedo*-24,30-dinoroleana-1(10),5,7-trien-3-yl]oxy]-3-hydroxy (20β) (R_1= R_2= OH , 7,8 - dehydro)	*Maytenus chuchuhuasca* R. Hamet et Colas		95
2. Two - ether linkage dimers			
2.1)Pristimerin-pristimerin type			
Cangorosin A 	*Maytenus ilicifolia* Mart. ex Reiss.	root	95 , 123 - 124

Table3. (continued)

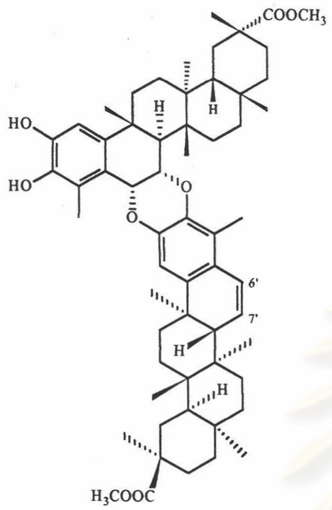
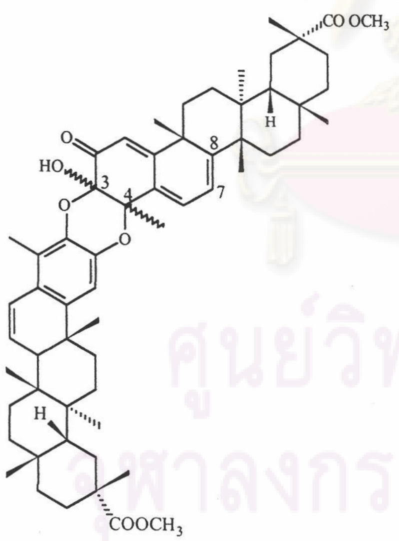
Compound/Structure	Plant source		Reference
Isocangorosin A 	*Maytenus ilicifolia* Mart. ex Reiss.	root	95 , 123 - 124
6',7'- Dihydroisocangorosin A (6',7'- dihydro)	*Maytenus ilicifolia* Mart. ex Reiss.	root	95 , 123 - 124
Scutionin αA  (3β - OH , 4β - CH_3)	*Maytenus scutioides* (Griseb.) Lourteig et O' Donell	root - bark	26
7,8-Dihydro-scutionin αA (3β - OH , 4β - CH_3 , 7,8 - dihydro)	*Maytenus scutioides* (Griseb.) Lourteig et O'Donell	root - bark	26

Table3. (continued)

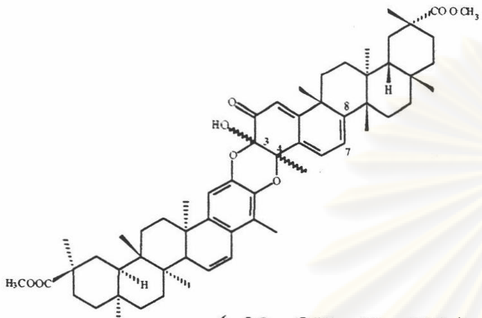
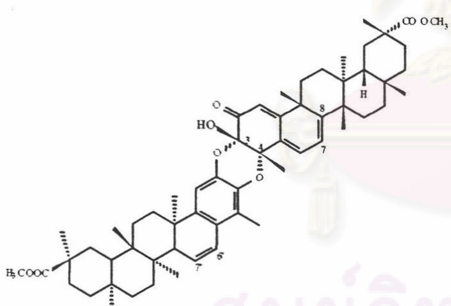
Compound/Structure	Plant source		Reference
7,8-Dihydro-scutionin βA (3α - OH, 4α - CH_3, 7,8 - dihydro)	*Maytenus scutioides* (Griseb.) Lourteig et O'Donell	root - bark	26
7,8-Dihydro-scutionin αB  (3β - OH , 4β - CH_3)	*Maytenus scutioides* (Griseb.) Lourteig et O'Donell	root - bark	26
7,8-Dihydro-scutioninβB (3α - OH , 4α - CH_3)	*Maytenus scutioides* (Griseb.) Lourteig et O'Donell	root - bark	26
Scutionin α B 	*Maytenus blepharodes* Lundell	root	125
	Maytenus magellanica Lam.	root - bark	125
6',7'-Dihydroscutionin α B (6',7'- Dihydro)	*Maytenus blepharodes* Lundell	root	125
	Maytenus magellanica Lam.	root - bark	125
6'β-methoxy-dihydro-scutionin αB (6',7'- Dihydro , 6'β- methoxy)	*Maytenus blepharodes* Lundell	root	125
	Maytenus magellanica Lam.	root - bark	125

Table3. (continued)

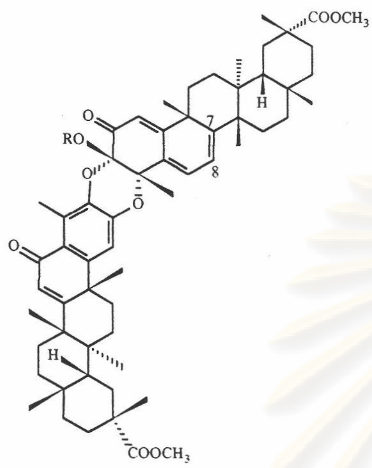
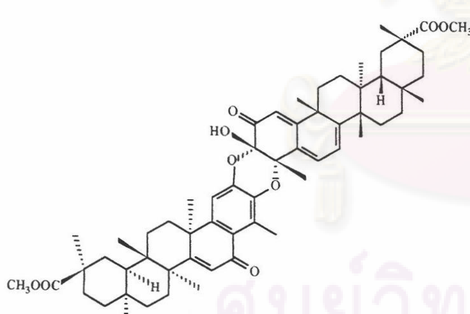
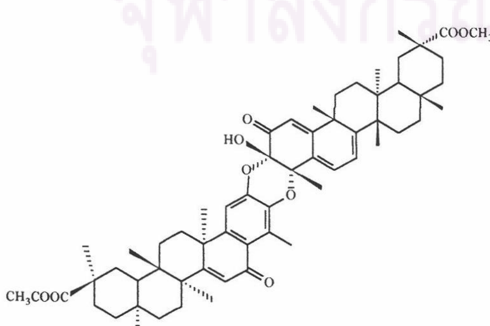
Compound/Structure	Plant source		Reference
Scutidin αA 	*Maytenus scutioides* (Griseb.) Lourteig et O'Donell	root - bark	26
7,8-dihydroisoxuxuarine Eα (R = H , 7,8-dihydro)	*Maytenus chuchuhuasca* Raymond - Hamet et Colas	bark	126
7,8-Dihydro-scutidin αB 	*Maytenus scutioides* (Griseb.) Lourteig et O'Donell	root bark	26
Xuxurine Eα 	*Maytenus blepharodes* Lundell	root	127

Table3. (continued)

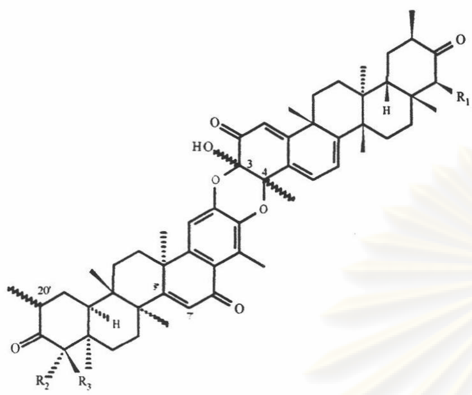
Compound/Structure	Plant source		Reference
2.2 Tingenone - tingenone Type Xuxuarine Aα  (3β - OH , 4β - CH_3 , 20'α - CH_3 , R_1= R_2= R_3= H)	*Maytenus chuchuhuasca* R. Hamet et Colas	bark	60
Xuxuarine Aβ (3α - OH , 4α - CH_3 , 20'α - CH_3 , R_1= R_2= R_3= H)	*Maytenus chuchuhuasca* R. Hamet et Colas	bark	60
Xuxuarine Bα (3β - OH , 4β - CH_3 , 20'α - CH_3 , R_1= R_3 = OH , R_2= H)	*Maytenus chuchuhuasca* R. Hamet et Colas	bark	60
Xuxuarine Bβ (3α - OH , 4α - CH_3 , 20'α - CH_3 , R_1= R_3 = OH , R_2= H)	*Maytenus chuchuhuasca* R. Hamet et Colas	bark	60
Xuxuarine Cα (3β - OH , 4β - CH_3 , 20'α - CH_3 , R_1= OH , R_2= R_3 = H)	*Maytenus chuchuhuasca* R. Hamet et Colas	bark	60
Xuxuarine Cβ (3α - OH , 4α - CH_3 , 20'α - CH_3 , R_1= OH , R_2= R_3= H)	*Maytenus chuchuhuasca* R.Hamet et Colas	bark	60
Xuxuarine Dα (3β - OH , 4β - CH_3 , 20'α - CH_3 , R_1 = R_3 = H, R_2= OH)	*Maytenus chuchuhuasca* R.Hamet et Colas	bark	60
Xuxuarine Dβ (3α - OH , 4α - CH_3 , 20'α - CH_3 , R_1= R_3= H , R_2= OH)	*Maytenus chuchuhuasca* R.Hamet et Colas	bark	60

Table3. (continued)

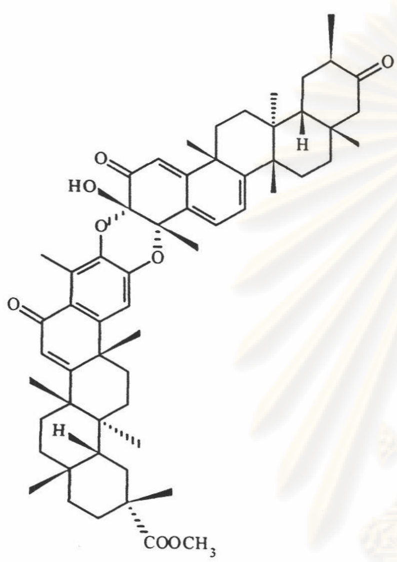
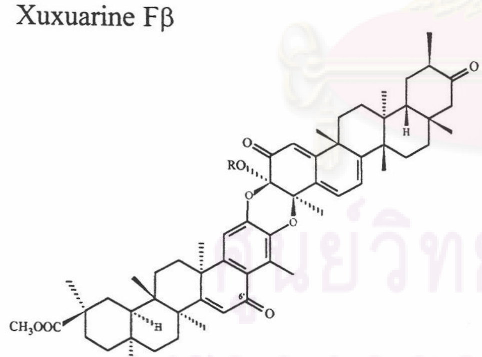
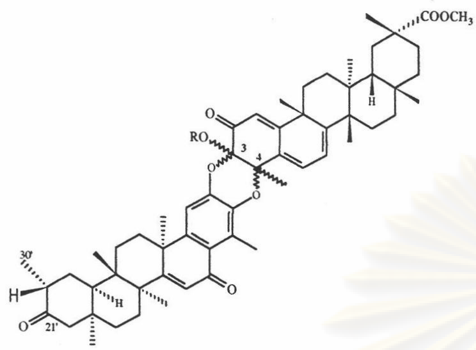
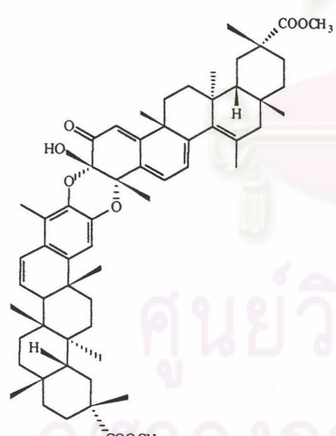
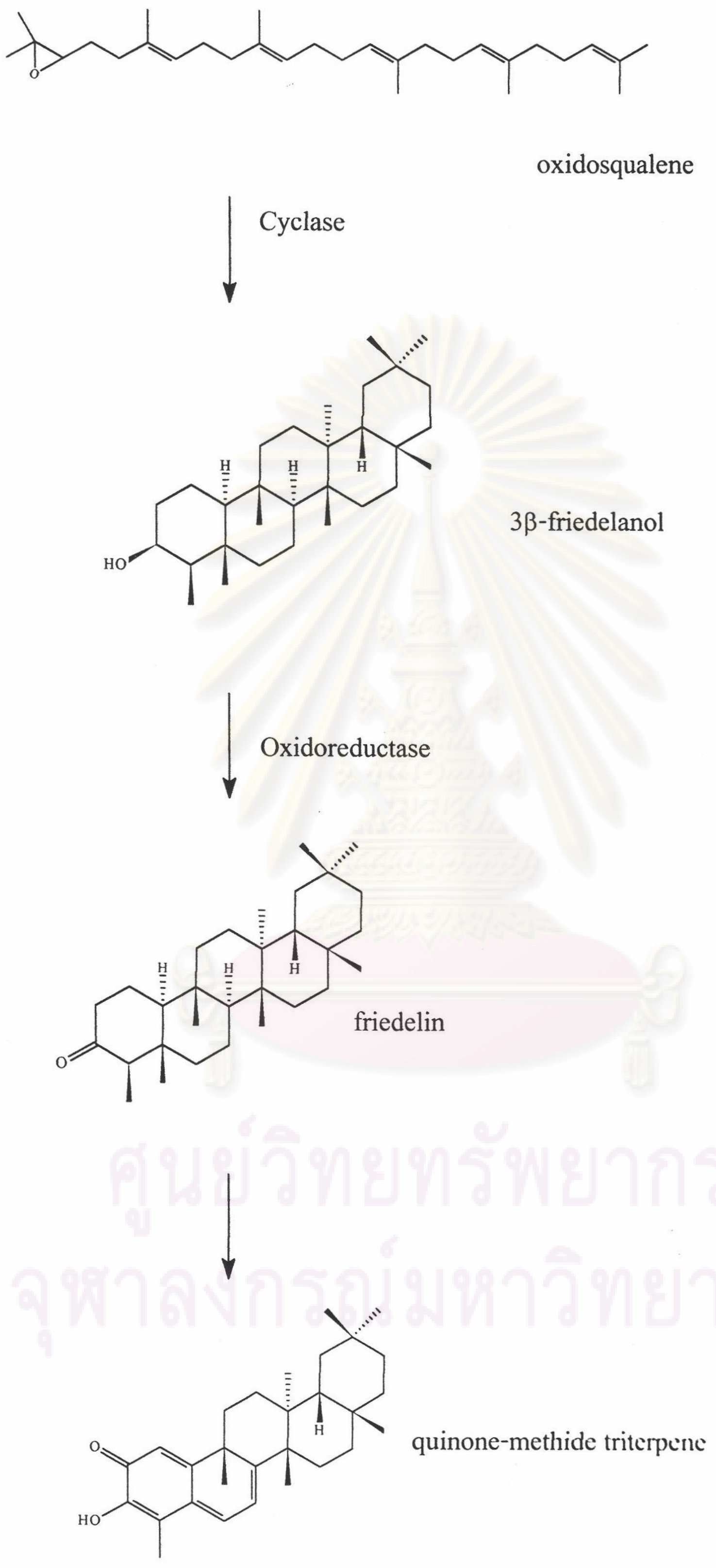
Compound/Structure	Plant source		Reference
7’,8’-Dihydroxuxuarine Aβ (3α - OH , 4α - CH_3 , 20’α - CH_3 , 7’,8’dihydro, R_1= R_2=R_3=H)	*Maytenus chuchuhuasca* R.Hamet et Colas	bark	60
2.3 Pristimerin – tingenone type			
Cangorosin B 	*Maytenus ilicifolia* Mart. ex Reiss.		95 , 124
Xuxuarine Fβ  (R = H)	*Maytenus chuchuhuasca* R.Hamet et Colas	stem bark	126

Table3. (continued)

Compound/Structure	Plant source		Reference
Xuxuarine Gα (R = H, *cis* 3,4 – dioxy bond = α)	*Maytenus chuchuhuasca* R. Hamet et Colas	stem bark	126
			
Xuxuarine Gβ (R = H, *cis* 3,4 - dioxy bond = β)	*Maytenus chuchuhuasca* R. Hamet et Colas	stem bark	126
2.4 Pristimerin - netzahualcoyone type Netzascutionin α A	*Maytenus scutioides* (Griseb.) Lourteig et O'Donell	root bark	26
			

2.2) Biosynthesis of quinone-methide triterpenes

The entry point for biosynthesis of quinone-methides requires oxidosqualene as a central intermediate, which by the action of a cyclase would give rise to the first cyclic intermediate, 3β-friedelanol and then, by the action of an oxidoreductase, the conversion to friedelin should occur between leaves and root bark. The transformation/translocation steps for the quinone-methide triterpenes should take place in the root bark .[128] (Scheme 1.)



Scheme1. Conversion of oxidosqualene to 3β- friedelanol and friedelin and their involvment as the biosynthetic precursor to the quinone - methide triterpene.

3. Oleanane Triterpenes in Celastraceae

Naturally occurring oleanane triterpenes found in the family Celastraceae up to the year 2002 are summarized in Figure 3 and Table 4 .

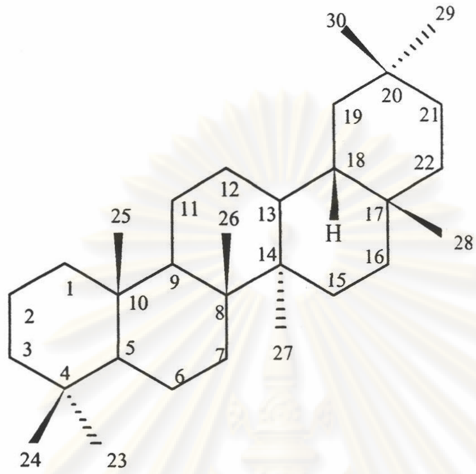


Figure 3. Basic structure of oleanane triterpene

Table 4. Naturally occurring oleanane triterpenes in Celastraceae.

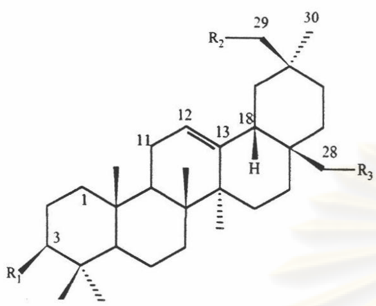
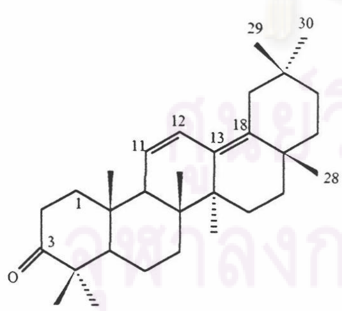
Compound / Structure	Plant source		Reference
β-amyrin (R_1= OH , R_2 = R_3= H)	*Acanthothamus aphyllus* T. S. Brandegee	root	44
	Celastrus paniculatus Willd.		3
	Celastrus scandens Linn.		3
	Lophopetalum wightianum Wight ex Arn.		3
	*Maytenus arbutifolia* (A. Rich.) Wilezek	leaves	129
	Maytenus canariensis (Loes.) Kunkel et Sunding		3
	Maytenus heterophylla (Eckl. & Zeyh.)	stem bark	129
Paniculatadiol (R_1= OH , R_2= OH , R_3= H)	*Celastrus paniculatus* Willd		3
Erythrodiol (R_1= OH , R_2= H , R_3= OH)	*Pristimera grahamii* Miers		3
3-oxo-olean-11, 13(18)-ene	*Maytenus disperma* (F. Muell.) Loes.		3
			

Table 4. (continued)

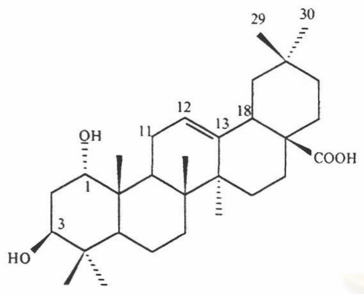
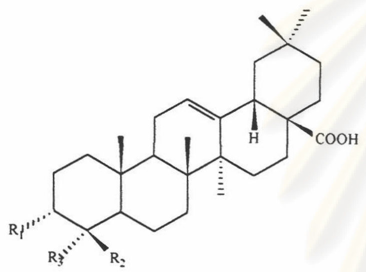
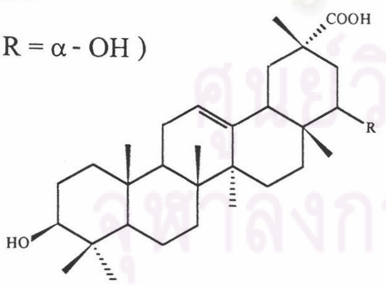
Compound / Structure	Plant source		Reference
Crataegolic acid 	*Euonymus latifolius* L.		3
3α,23-Dihydroxy-olean-12-en-28-oic acid (R_1= OH , R_2= CH_3 , R_3= CH_2OH) 	*Tripterygium wilfordii* Hook.f.	root bark	130
3α,24-Dihydroxy-olean-12-en-28-oic acid (R_1= OH , R_2= CH_2OH , R_3= CH_3)	*Tripterygium wilfordii* Hook.f.	root bark	130
3β,22α-Dihydroxyolean-12-en-29-oic acid (R = α - OH) 	*Salacia oblonga* Wall.	root	35
3β,22β-Dihydroxyolean-12-en-29-oic acid (R = β - OH)	*Tripterygium wilfordii* Hook. f.		131

Table 4. (continued)

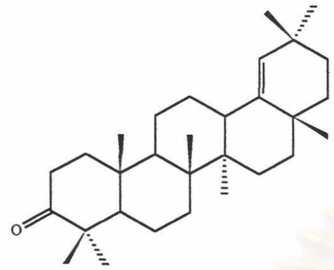
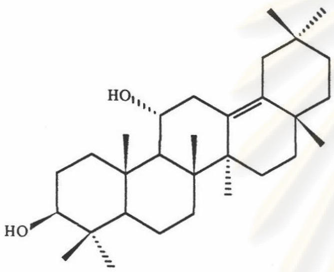
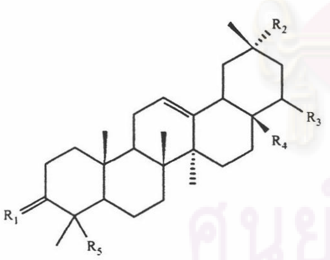
Compound / Structure	Plant source		Reference
Germacinone 	*Acanthothamus aphyllus* T.S. Brandegee	root	44
Hypodiol 	*Tripterygium hypoglaucum* (Levl.)Hutch	outer root bark	132
	Tripterygium wilfordii var. regelli	root	5
3-Oxo-olean-12-en-29-oic acid (R_1= O , R_2= COOH , R_3= H , R_4= CH_3 , R_5= CH_3) 	*Austroplenckia populnea* (Reiss) Lundell	bark wood	131
Mupinensisone (R_1= O , R_2= OH , R_3= H , R_4= CH_3 , R_5= CH_3)	*Euonymus mupinensis* L.		131
29-Hydroxy-3-oxo-olean-12-en-28-oic acid (R_1= O , R_2= CH_2OH , R_3= H , R_4= COOH , R_5= CH_3)	*Tripterygium wilfordii* Hook.f.	root	5
22α-Hydroxy-3-oxo-olean-12-en-29-oic acid (R_1= O , R_2= COOH , R_3= α - OH , R_4= R_5= CH_3)	*Tripterygium wilfordii* Hook.f.	root	5

Table 4. (continued)

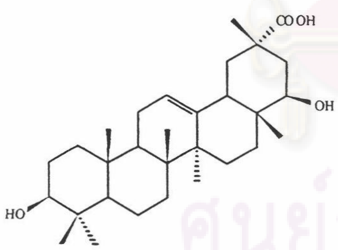
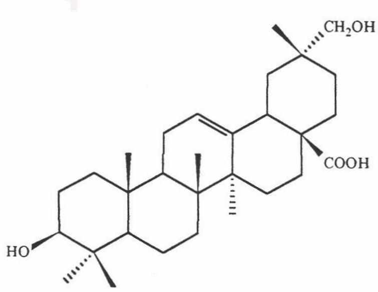
Compound / Structure	Plant source		Reference
22β-Hydroxy-3-oxo-olean-12-en-29-oic acid (R_1= O , R_2= COOH , R_3= β - OH , R_4= R_5= CH_3)	*Tripterygium wilfordii* Hook.f.	root	5
24-Hydroxy-3-oxo-olean-12-en-28-oic acid (R_1= O, R_2= CH_3 , R_3= H , R_4= COOH , R_5= β CH_2OH)	*Tripterygium wilfordii* Hook.f.	root	5
23-Hydroxy-3-oxo-olean-12-en-28-oic acid (R_1= O, R_2= CH_3 , R_3= H , R_4= COOH , R_5= α CH_2OH)	*Tripterygium wilfordii* Hook.f.	root	5
Methyl katonoate (R_1= O , R_2= $COOCH_3$, R_3 = H , R_4 = CH_3 , R_5= CH_3)	*Tripterygium wilfordii* var.*regelii* Makino	stem	133
Maytenfolic acid 	*Acanthothamus aphyllus* T.S. Brandegee	root	44
	Maytenus heterophylla (Eckl. & Zeyh.)	stem bark	129
	Salacia oblonga Wall.	root	35
Mesembryanthemoidigenic acid 	*Trypterygium hypoglaucum* (Levl.)Hutch	outer root bark	132

Table 4. (continued)

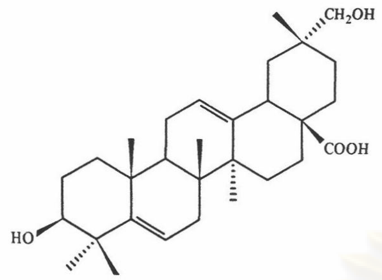
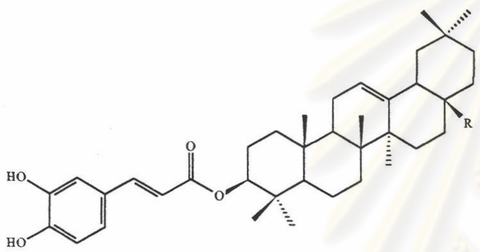
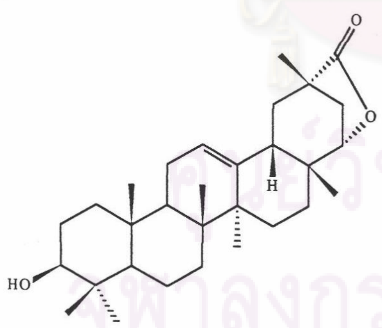
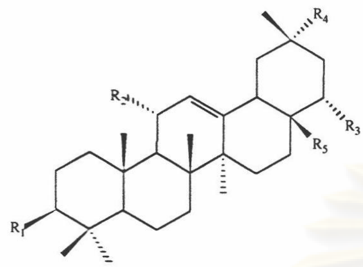
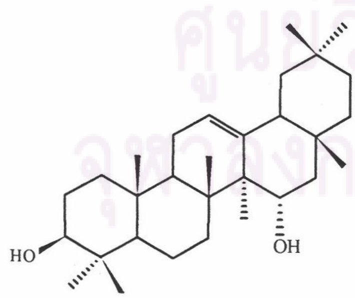
Compound / Structure	Plant source		Reference
Hypoglauterpenic acid 	*Tripterygium hypoglaucum* Hutchinson		131
Olean-28-al-3β-yl caffeate (R = CHO) 	*Celastrus stephanofolius* L.	stem	134
Olean-28-oic-3β-yl caffeate (R = COOH)	*Celastrus stephanofolius* L.	stem	134
Regelide 	*Tripterygium regeli* Hook. f.		131
	Tripterygium wilfordii Hook. f.	root	133
	Tripterygium wilfordii var. *regelii* Makino	dry stalk	133

Table 4. (continued)

Compound / Structure	Plant source		Reference
Triptohypol F (R_1= OH, R_2= OCH_3 , R_3= H , R_4= R_5= CH_3) 	*Tripterygium hypoglaucum* (Levl.)	root bark	135
Oleanic acid 3-*O*-acetate (R_1= $OCOCH_3$, R_2 = R_3 = H , R_4 = CH_3 , R_5= COOH)	*Tripterygium hypoglaucum* (Levl.)	root bark	135
Triptocallic acid D (R_1= α - OH , R_2= H , R_3 = OH , R_4= COOH , R_5 = CH_3)	*Tripterygium hypoglaucum* (Levl.)	root bark	135
	Tripterygium wilfordii var.*regelii* Makino	callus-culture	136
3-Epikatonic acid (R_1 = OH , R_2 = R_3 = H , R_4 = COOH , R_5= CH_3)	*Tripterygium hypoglaucum* (Levl.)	root bark	135
3β,15α- Dihydroxy-olean-12-ene 	*Schaefferia cuneifolia* Jacq.		131