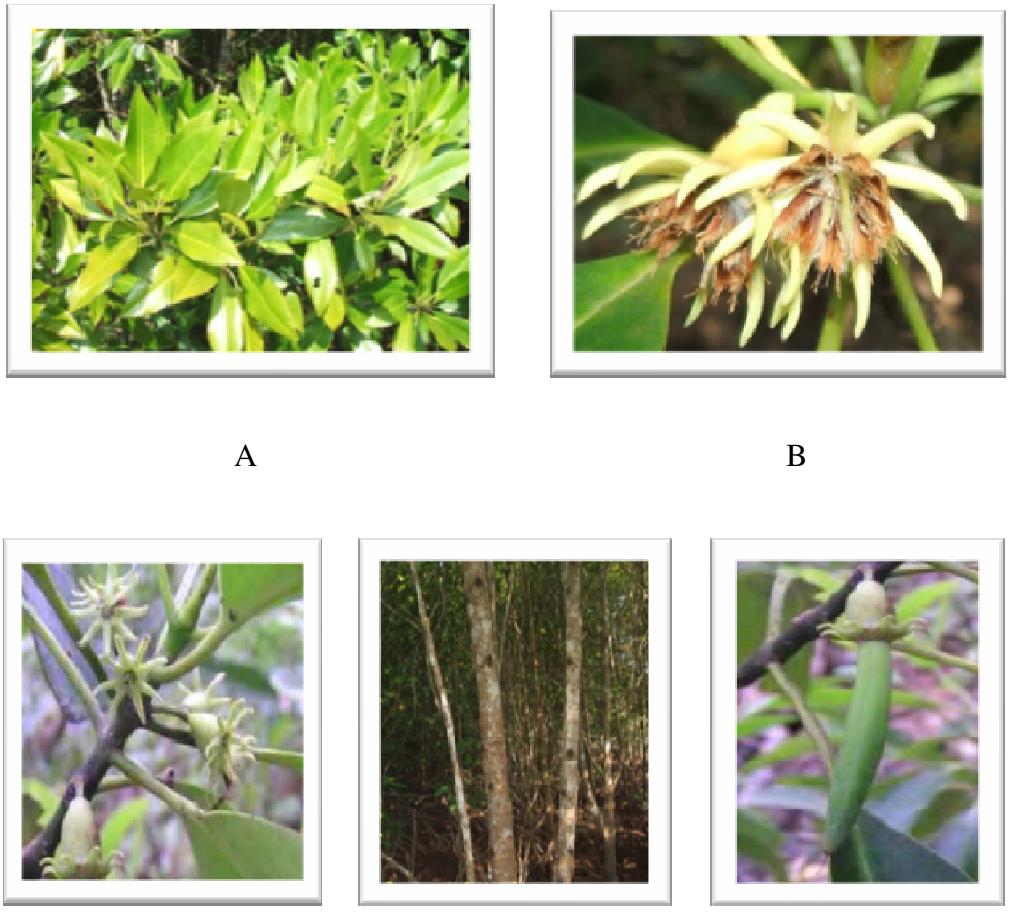
CHAPTER 1
INTRODUCTION

1.1 Introduction

Bruguiera cylindrica (**Figure**s **1A-1F**) is a mangrove plant in Rhizophoraceae family, distributing in South East Asia throughout North Queensland (Hou, 1970). In Thailand, Rhizophoraceae family comprises 9 genera, *Bruguiera*, *Carallia*, *Ceriops*, *Gynotroches*, *haloragis*, *Kandelia*, *Myriophyllum*, *Pellacalyx and Rhizorphora*. Only 5 species of *Bruguiera* genus are found in Thailand (Smitinand, 2001): *B. cylindrica*, *B. parviflora*, *B. gymnorhiza*, *B. hainesii* and *B. sexagulata*.

B. cylindrica is a small tree (compared to the big *Rhizophoras*) typically reaching 8-15 m high in favourable habitat. It appears to fit the distribution of a back mangrove but generalization about its ecological distribution is hard to make as *B. cylindrica* has also been found in small, pure stands in open or disturbed sites within the stand of larger, ecodominant *Rhizorphora* species.

B. cylindrica has elliptic leaves ca. 10 cm long. The flowers are white with perhaps a greenish tint and often in small clusters of 3-5 flowers. The calyx is distinctive and persistant; being reflexed and forming a prominent “cap”, curving above the hypocotyl. The fruit and hypocotyl look like a thin, slighly grooved purplish-green banana when mature. The bark is grey and the tree may produce buttresses. In Thailand, *B. cylindrica* has been found in Chanthaburi, Satun, Phetchaburi. It has many local Thai names: Thua Deng (ถั่วแดง), Prasak Khao (ประสักขาว), Prui (ปรุ้ย), Prong (โปรง) and Rui (รุ่ย) (Smitinand, 2001).



A B C D E

Figure 1 The leaves, flowers, fruits, stems and hypocotyls of *Bruguiera cylindrica* (A-E)

1.2 Review of Literatures

Chemical constituents isolated from the four species of this genus were summarized in **Table 1**. Information from the NAPRALERT database developed by University of Illinois in Chicaco and Scifinder Scholar copyright in 2005 will be presented and classified into groups: Alkaloids, Aromatics, Biflavans, Disulfides, Diterpenoids, Flavonoids, Steroids and Triterpenoids.

Table 1 Compounds from plants of Bruguiera genus.

a. Alkaloids
b. Aromatics
c. Benzenoids
d. Carbohydrates
e. Coumarins
f. Diterpenes
g. Flavonoids
h. Lipids
i. Quinoids
j. Steroids
k. Sulfur compounds
l. Triterpenes

Scientific name	Part	Compounds	Bibliography
B. conjugate	Stems	Brugierol, **k2**	Kato *et al*.,1972 and 1980
		Iso-brugierol, **k3**	
	Barks	Brugierol acetate, **k4**	Kato *et al*., 1972
	Roots	Iso-brugierol acetate, **k5**	
B. cylindrica	Stems	Brugierol, **k2**	Kato *et al*., 1975 and 1976
	Barks	Iso-brugierol, **k3**	
		4-Hydroxy-1,2-dithiolane, **k1**	
		1,2-Dithiolan-4-ol, phenylcarbamate, **a9**	
		Brugine, **a1**	
	Fruits	3α-*E*-Feruloyltaraxerol, **l14**	Laphookhieo *et al*., 2004
		3α-*Z*-Feruloyltaraxerol, **l15**	
		3β-*E*-Feruloyltaraxerol, **l16**	
		3β-*Z*-Feruloyltaraxerol, **l17**	
		3α-*E*-Coumaroyltaraxerol, **l18**	
		3α-*Z*-Coumaroyltaraxerol, **l19**	
		3α-Taraxerol, **l5**	
		3β-Taraxerol, **l6**	

Table 1 (continued)

Scientific name	Part	Compounds	Bibliography
B. cylindrica	Fruits	Dioslupesin A, **l21** 3α-*Z*-Coumaroyllupeol, **l22** 3β-*E*-Coumaroyllupeol, **l23** 3β-*Z*-Coumaroyllupeol, **l24** 3β-*E*-Feruoyllupeol, **l25** 3β-*E*-Caffeoyllupeol, **l27** 3β -*Z*-Feruoyllupeol, **l26** 3β-*E*-Caffeoyltaraxerol, **l29** 3α-Lupeol, **l1** 3β-Lupeol, **l2** Lupenone, **l3**	Karalai *et al*., 2005
B. exaristata	Leaves Stem barks	1-D-1-*O*-Methyl muco inositiol, **d1** Brugine, **a1** Tropine, **a2** Tropine acetate, **a3** Tropine iso-butyrate, **a4** Tropine iso-valerate, **a5** Tropine propionate, **a6** Tropine n-butyrate, **a7**	Richter *et al*., 1990 Loder *et al*., 1969
B. gymnorhiza	Leaves	Gramrinone, **g1** 3β -Taraxerol, **l6**	Raihan *et al*., 1994 Raihan *et al*., 1995 Williums *et al*., 1999

Table 1 (continued)

Scientific name	Part	Compounds	Bibliography
B. gymnorhiza	Leaves	3β-Lupeol, **l2**	Raihan *et al*., 1995 Ghosh *et al*., 1985
		Lupenone, **l3** 3β-Amyrin palmitate, **l12** 3β-Lupeol stearate, **l11**	Raihan *et al*., 1995
		3β-Sitosterol, **j4**	Sarkar *et al*., 1978 Ghosh et al., 1985
		3α-Amyrin, **l7**	Ghosh *et al*., 1985
		3β-Amyrin, **l8**	Ghosh *et al*., 1985 Raihan *et al*., 1995
		Campesterol, **j1** 28-Iso-fucosterol, **j6** Stigmasterol, **j3**	Misra *et al*., 1986
		Cholesterol, **j2** Oleanolic acid, **l10** 25(*S*)-Stigmast-7-ene-3β-ol, **j5** Ursolic acid, **l9**	Ghosh *et al*., 1985
		Gymnorhizol, **l4**	Sarkar *et al*., 1978
	Stems	(4*R*,5*S*,8*R*,9*R*,10*S*,13*S*)-*ent*-9(11)-en-17-Hydroxy-16-oxobeyeran-19-al, **f26** 17-Chloro-13,16β-dihydroxy-*ent*-kauran-19-al, **f9** 13,16α,17-Trihydroxy-*ent*-9(11)-kaurene-19-oic acid, **f10** 16α,17-Dihydroxy-*ent*-9(11)-kaurene-19-al, **f12** *ent*-Kaur-16-ene-19-ol, **f15**	Han *et al*., 2004

Table 1 (continued)

Scientific name	Part	Compounds	Bibliography
B. gymnorhiza	Stems	*ent*- Kaur-16-ene-13,19-diol, **f3** Methyl-16α,17-dihydroxy-*ent*-9(11)-kauren-19-oate, **f23** 16α *H*-17,19-*ent*-Kauranediol, **f16** 16β *H*-17-Hydroxy-*ent*-kauran-19-oic acid, **f17** 16α-17-Dihydroxy-*ent*-kauran-19-al, **f14** *ent*-Kaur-16-en-13-hydroxy-19-al, **f5** Methyl-16α,17-dihydroxy-*ent*-kauran-19-oate, **f11**	Han *et al*., 2004
		1*H*-2-Benzopyran-6,8-diol, 3,4-dihydro-3-(3-hydroxybutyl)-1,1-dimethyl, **b1** 2,5-Hexanediol, 1,3-hydroxyphenyl, **b2** Bruguierol A, **b3** Bruguierol B, **b4** Bruguierol C, **b5** Isopimar-7-ene-15*S*,16-diol, **f2** *ent*-8(14)-Pimarene-1α,15*R*,16-triol, **f1** *ent*-8(14)-Pimaren-1-oxo-15*S*,16-diol, **f18** Isopimar-7-ene-1β,15*S*,16-triol, **f19**	Han *et al*., 2005

Table 1 (continued)

Scientific name	Part	Compounds	Bibliography
B. gymnorhiza	Stems	Isopimar-8-ene-15*R*,16-diol, **f20** *ent*-8(14)-Pimarene-1*β*,15*R*,16-triol, **f21**	Han *et al*., 2005
	Root barks	Methyl-*ent*-kaur-9(11)-en-13,17-epoxy-16-hydroxy-19-oate, **f6** *ent*-8(14)-Pimarene-1*β*,15*R*,16-triol, **f21** *ent*-Kaur-16-en-13-hydroxy-19-oic acid, **f4** Isopimar-7-ene-15*S*,16-diol, **f2** *ent*- Kaur-16-ene-13,19-diol, **f3** 1,2-Ethanediol, 1-[(2*S*,4a*S*,4b*S*,8a*S*)-1,2,3,4,4a,4b,5,6,7,8,8a,9-dodecahydro-2,4b,8,8-tetramethyl-2- phenanthrenyl]-,diacetate, (1S), **f7** 2-Phenanthrenecarboxaldehyde, 1,2,3,4,4a,4b,5,6,7,8,8a,9-dodecahydro-2,4b,8,8-tetramethyl-, (2S,4aS,4bS,8aS), **f8** *ent*-Kaur-16-en-13-hydroxy-19-al, **f5**	Subrahmanyam *et al*., 1999
	Woods	Ellagic acid, **e1** 3, 3'-Dimethoxy ellagic acid, **e2**	Lowry *et al*., 1968

Table 1 (continued)

Scientific name	Part	Compounds	Bibliography
B. gymnorhiza	Flowers	Brugierol, **k2** Iso-brugierol, **k3** Bruguierin A, **l30** Bruguierin B, **l31** Bruguierin C, **l32**	Kato *et al*., 1975 Kato *et al*., 1976 Homhual *et al*.,2006
B. parviflora	Barks	[4,8"-Biflavan]-3,3',3",3"',4',4"',5,5",7,7"-decol, 4"-[[2-(3,4-dihydroxyphenyl)-3,5,7-trihydroxy-4-chromanyl]oxy], **c1** [4,8"-Biflavan]-3,3"-diol, 3',3"',4',4"',5,5",7,7"-octamethoxy-4"-[[2-(3,4-dimethoxyphenyl)-3-hydroxy-5,7-dimethoxy-4-chromanyl]oxy]-,Triacetate, **c2** [4,8"-Biflavan]-3,3"-diol, 3',3"',4',4"',5,5",7,7"-octamethoxy-4"-[[2-(3,4-dimethoxyphenyl)-3-hydroxy-5,7-dimethoxy-4-chromanyl]oxy], **c3**	Seshadri *et al*.,1971

Table 1 (continued)

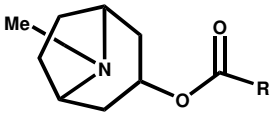
Scientific name	Part	Compounds	Bibliography
B. parviflora	Barks	[4,8"-Biflavan]-3,3',3",3"',4',4"',5,5",7,7"-decol,4"-[[2-(3,4-dihydroxyphenyl)-3,5,7-trihydroxy-4-chromanyl]oxy]-, pentadecaacetate, **c4**	Seshadri *et al.*,1971
	Fruits	3β-Lupeol, **l2** Lupenone, **l3** Dioslupesin A, **l21** 3α-*Z*-Coumaroyllupeol, **l22** 3β-*E*-Coumaroyllupeol, **l23** 3β-*Z*-Caffeoyllupeol, **l28**	Chumkaew *et al.*, 2005
B. sexagulata	Stem Barks	Brugine, **a1** Tropine, **a2** Tropine acetate, **a3** Tropine iso-butyrate, **a4** Tropine iso-valerate, **a5** Tropine propionate, **a6** Tropine n-butyrate, **a7** Tropine benzoate, **a8**	Loder *et al.*, 1969
	Roots	Apiculol, **f25**	Saxena *et al.*,1994
	Leaves Heart woods	Careaborin, **l13** Tetracosanoic, **h1** 2,6-Dimethoxy-1,4-benzoquinone, **i1** Campesterol, **j1**	Kokpol *et al.*, 1993

Table 1 (continued)

Scientific name	Part	Compounds	Bibliography
Barks	Barks	2,6-Dimethoxy-1,4-benzoquinone, **i1** 3,4-Dihydro-3-hydroxy-7-methoxy-2H-1,5-benzodithiepine-6,9-dione, **i2** Brugierol, **k2** iso-Brugierol, **k3** (4*R*,5*S*,8*R*,9*R*,10*S*,13*S*)-*ent*-17-Hydroxy-16-oxobeyeran-19-al, **f13** (16*R*)-13,17-Epoxy-16-hydroxy-*ent*-kaur-9(11)-en-19-al, **f22** Methyl-16α,17-dihydroxy-*ent*-9(11)-kauren-19-oate, **f23** 16,17-Dihydroxy-19-nor-*ent*-kaur-9(11)-en-3-one, **f27** Methyl-*ent*-kaur-9(11)-en-13,17-epoxy-16-hydroxy-19-oate, **f6** Methyl-*ent*-13,17-epoxy-16-hydroxykauran-19-oate, **f24** 16α,17-Dihydroxy-*ent*-9(11)-kaurene-19-al, **f12**	Bao *et al*., 2005

Structures

a. Alkaloids



R = H ; Tropine, **a2**

R = CH_3 ; Tropine acetate, **a3**

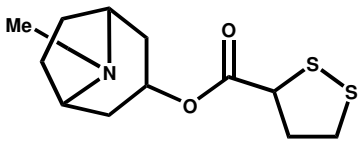
R = $CH(CH_3)_2$; Tropine iso-butyrate, **a4**

R = $CH_2CH(CH_3)_2$; Tropine iso-valerate, **a5**

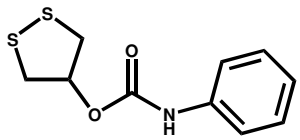
R = CH_2CH_3 ; Tropine propionate, **a6**

R = $(CH_2)_2CH_3$; Tropine butyrate, **a7**

R = Ph ; Tropine benzoate, **a8**

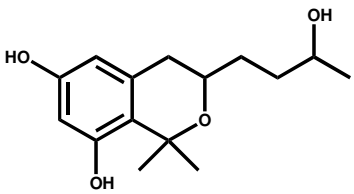


Brugine, **a1**

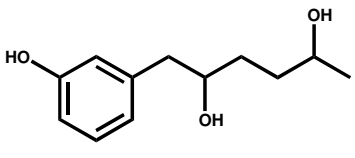


1,2-Dithiolan-4-ol, phenylcarbamate , **a9**

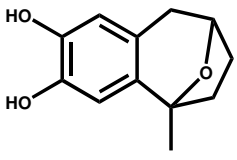
b. Aromatics



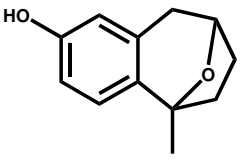
1*H*-2-Benzopyran-6,8-diol, 3,4-dihydro -3-(3-hydroxybutyl)-1,1-dimethyl, **b1**



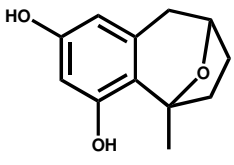
2,5-Hexanediol, 1,3-hydroxyphenyl, **b2**



Bruguierol A, **b3**

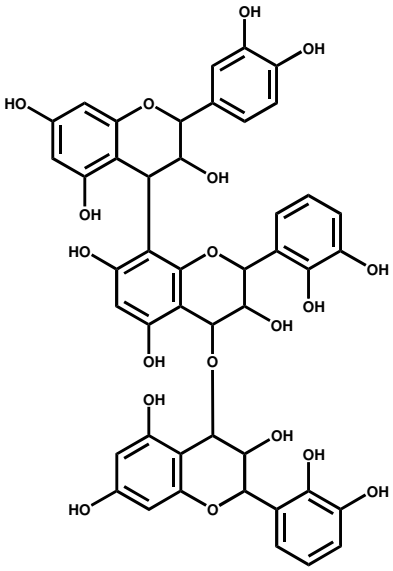


Bruguierol B, **b4**

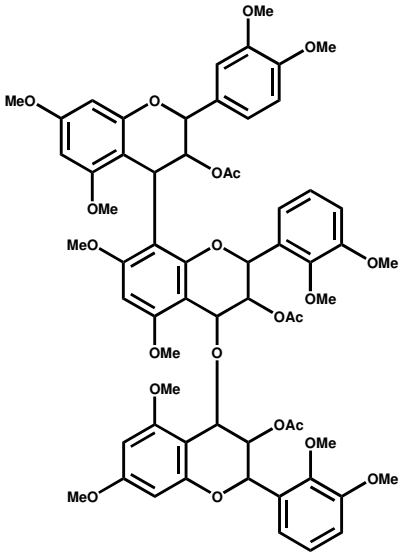


Bruguierol C, **b5**

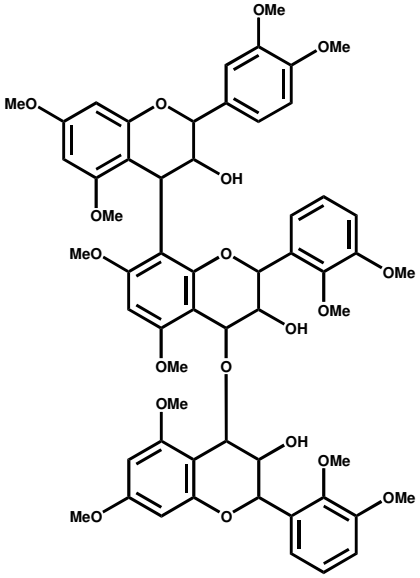
c. Benzenoids



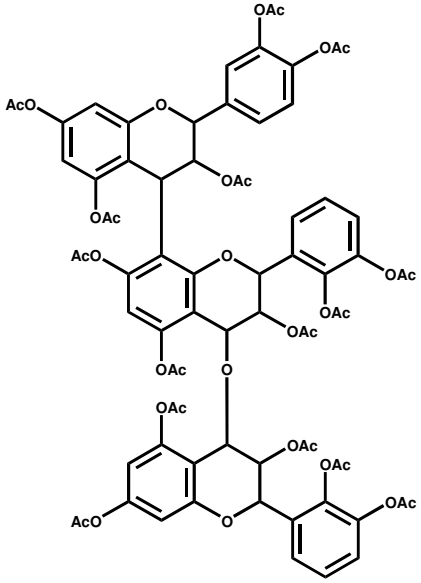
[4,8"-Biflavan]-3,3',3",3"',4',4"',5,5",7,7"-decol, 4"-[[2-(3,4-dihydroxyphenyl)-3,5,7-trihydroxy-4-chromanyl]oxy], **c1**



[4,8"-Biflavan]-3,3"diol,3',3"',4',4"',5,5",7,7"-octamethoxy-4"-[[2-(3,4-dimethoxyphenyl)-3-hydroxy5,7-dimethoxy-4-chromanyl]oxy]-, Triacetate, **c2**

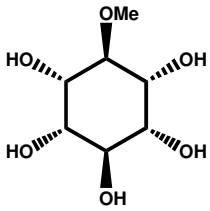


[4,8"-Biflavan]-3,3"-diol, 3',3"',4',4"',5,5",7,7"-octamethoxy-4"-[[2-(3,4-dimethoxyphenyl)-3-hydroxy-5,7-dimethoxy-4-chromanyl]oxy], **c3**



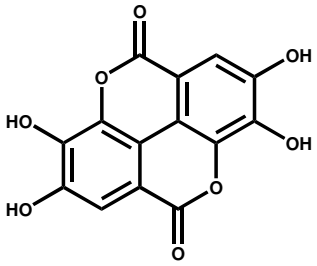
[4,8"-Biflavan]-3,3',3",3"',4',4"',5,5",7,7"-decol, 4"-[[2-(3,4-dihydroxyphenyl)-3,5,7-trihydroxy-4-chromanyl]oxy]-, pentadecaacetate, **c4**

d. Carbohydrates

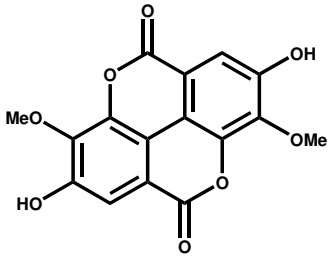


1-D-1-*O*-Methyl-muco-inositol,**d1**

e. Coumarins

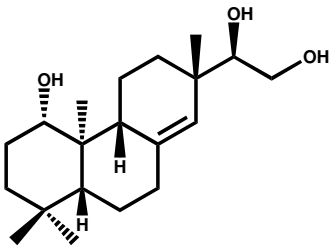


Ellagic acid, **e1**

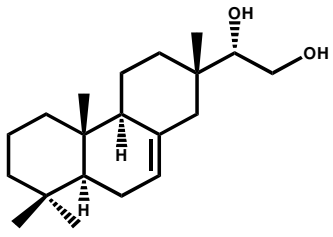


3, 3'-Dimethoxy ellagic acid, **e2**

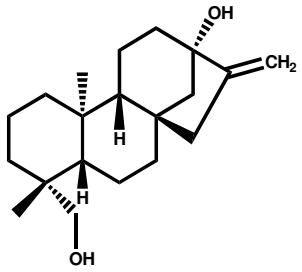
f. Diterpenoids



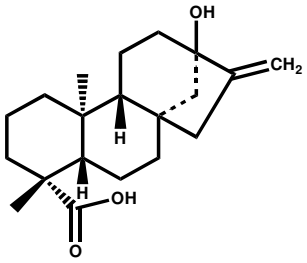
ent-8(14)-Pimarene-1α,15*R*,16-triol, **f1**



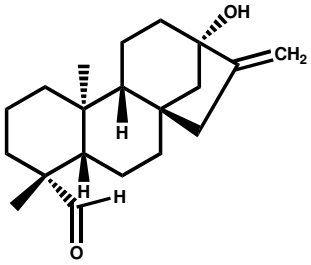
Isopimar-7-ene-15*S*,16-diol, **f2**



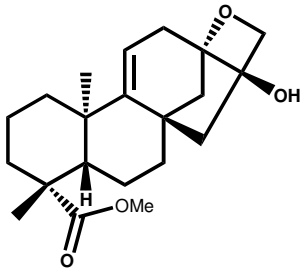
ent- Kaur-16-ene-13,19-diol, **f3**



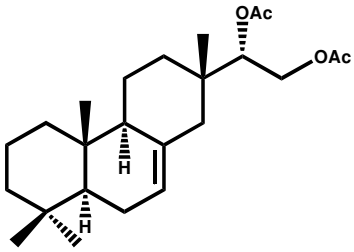
ent-Kaur-16-en-13-hydroxy -19-oic acid, **f4**



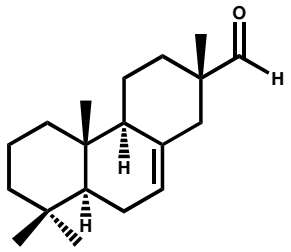
ent-Kaur-16-en-13-hydroxy-19-al, **f5**



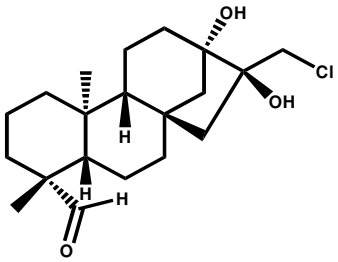
Methyl-*ent*-kaur-9(11)-en-13,17-epoxy-16-hydroxy-19-oate, **f6**



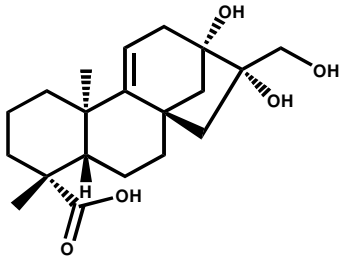
1,2-Ethanediol, 1-[(2*S*,4a*S*,4b*S*,8a*S*)-1,2,3,4,4a,4b,5,6,7,8,8a,9-dodecahydro -2,4b,8,8-tetramethyl-2- phenanthrenyl]-, diacetate, (1S), **f7**



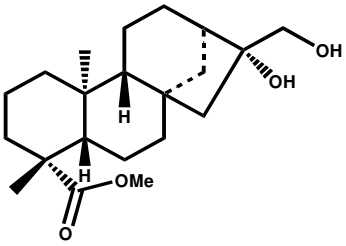
2-Phenanthrenecarboxaldehyde, 1,2,3,4, 4a,4b,5,6,7,8,8a,9-dodecahydro-2,4b,8,8-tetramethyl-, (2*S*,4a*S*,4b*S*,8a*S*), **f8**



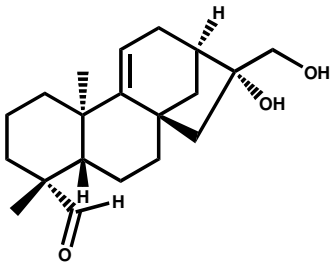
17-Chloro-13,16β-dihydroxy-*ent*-kauran-19-al, **f9**



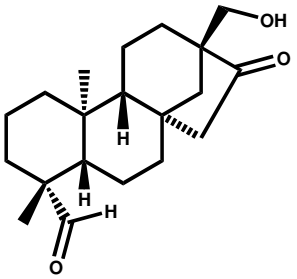
13,16α,17-Trihydroxy-*ent*-9(11)-kaurene-19-oic acid, **f10**



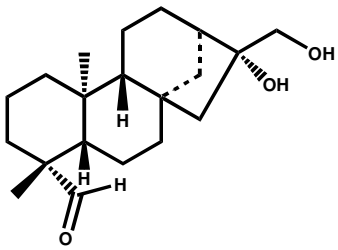
Methyl-16α,17-dihydroxy-*ent*-kauran-19-oate, **f11**



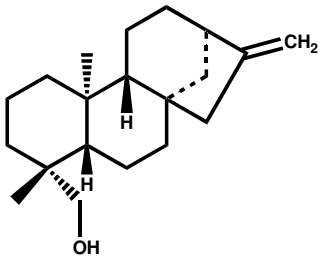
16α,17-Dihydroxy-*ent*-9(11)-kaurene-19-al, **f12**



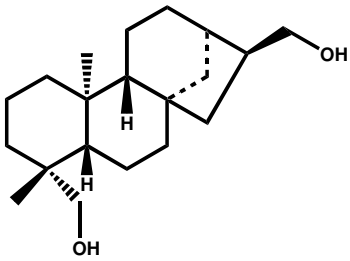
(4*R*,5*S*,8*R*,9*R*,10*S*,13*S*)-*ent*-17-Hydroxy-16-oxobeyeran-19-al, **f13**



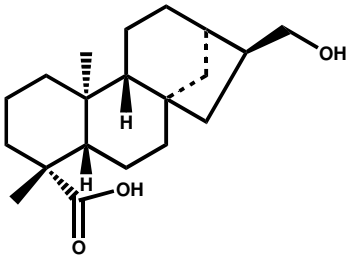
16α-17-Dihydroxy-*ent*-kauran-19-al, **f14**



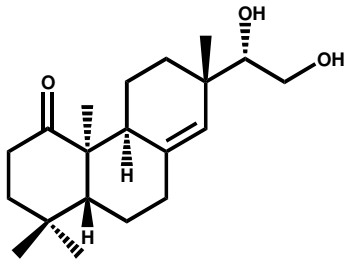
ent-Kaur-16-ene-19-ol, **f15**



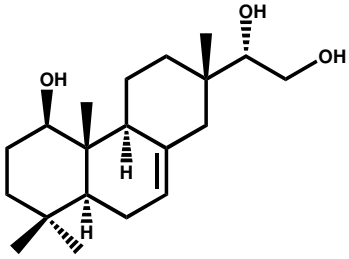
16α *H*-17,19-*ent*-Kauranediol, **f16**



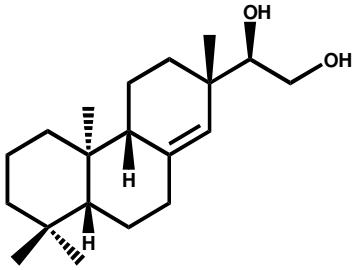
16β *H*-17-Hydroxy-*ent*-kauran -19-oic acid, **f17**



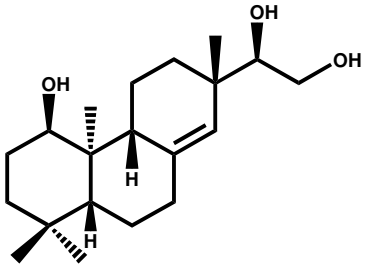
ent-8(14)-Pimaren-1-oxo-15*S*,16-diol, **f18**



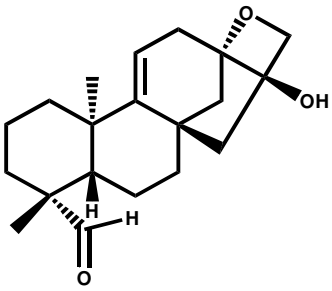
Isopimar-7-ene-1β,15*S*,16-triol, **f19**



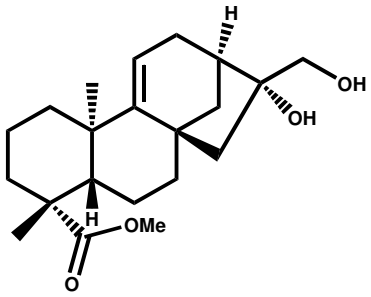
Isopimar-8-ene-15*R*,16-diol, **f20**



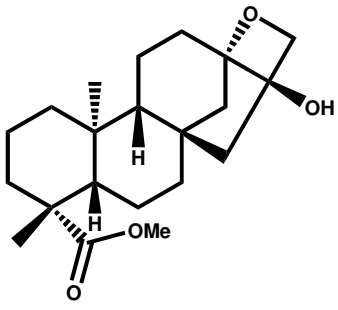
ent-8(14)-Pimarene-1β,15*R*,16-triol, **f21**



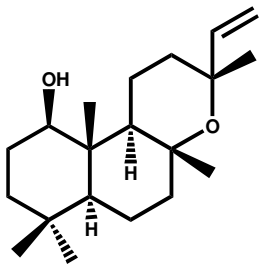
(16*R*)-13,17-Epoxy-16-hydroxy -*ent*-kaur-9(11)-en-19-al, **f22**



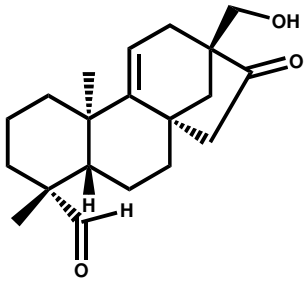
Methyl-16α,17-dihydroxy-*ent*-9(11)-kauren-19-oate, **f23**



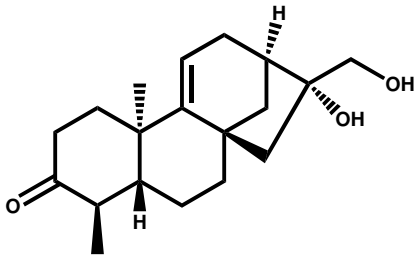
Methyl-*ent*-13,17-epoxy-16-hydroxykauran-19-oate, **f24**



Apiculol, **f25**

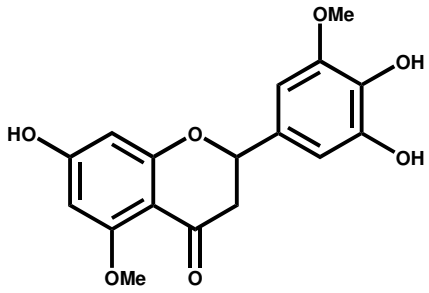


(4*R*,5*S*,8*R*,9*R*,10*S*,13*S*)-*ent*-9(11)-en 17-hydroxy-16-oxobeyeran-19-al, **f26**



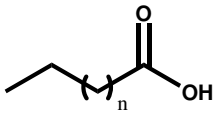
16,17-Dihydroxy-19-nor-*ent*-kaur-9(11)-en-3-one, **f27**

g. Flavonoids



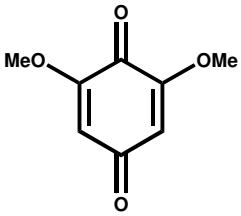
Gramrinone, **g1**

h. Lipids

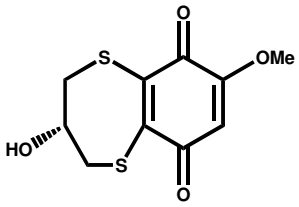


n = 21, Tetracosanoic, **h1**

i. Quinoids

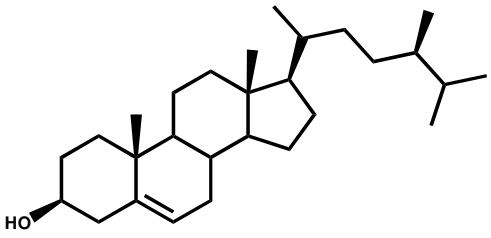


2,6-Dimethoxy-1,4-benzoquinone, **i1**

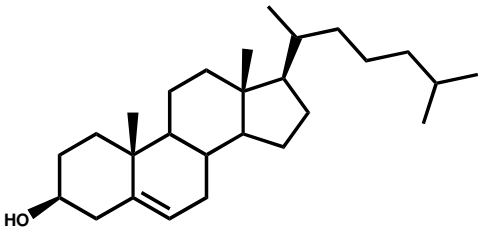


(-)-3,4-Dihydro-3-hydroxy-7-methoxy-2H-1,5-benzodithiepine-6,9-dione, **i2**

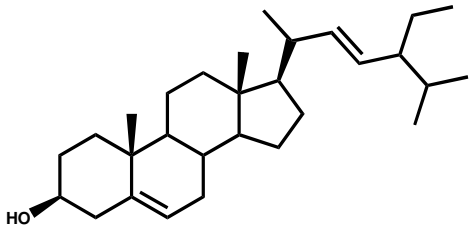
j. Steroids



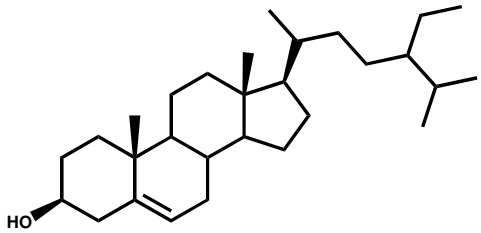
Campesterol, **j1**



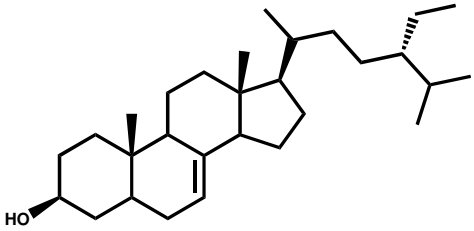
Cholesterol, **j2**



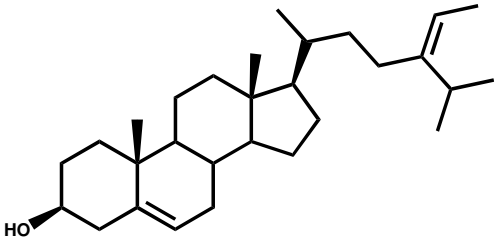
Stigmasterol, **j3**



Sitosterol, **j4**

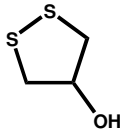


25(*S*)-Stigmast-7-en-3β-ol, **j5**

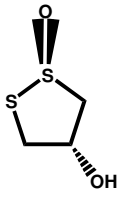


28-iso-Fucosterol, **j6**

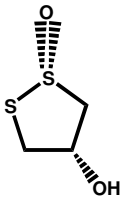
k. sulfur compounds



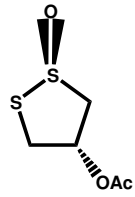
4-Hydroxy-1,2-dithiolane, **k1**



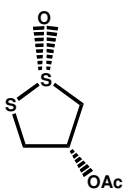
Brugierol, **k2**



iso-Brugierol, **k3**

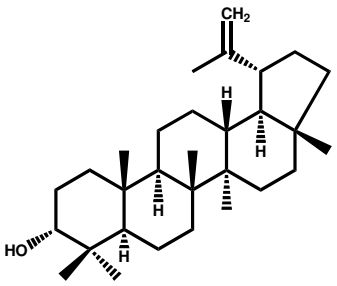


Brugierol acetate, **k4**

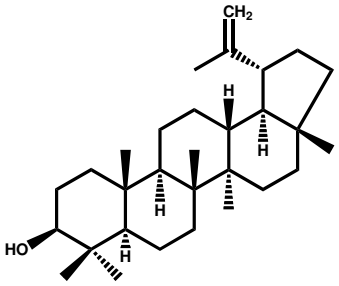


iso-Brugierol acetate, **k5**

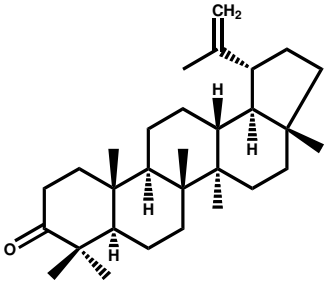
l. Triterpenoids



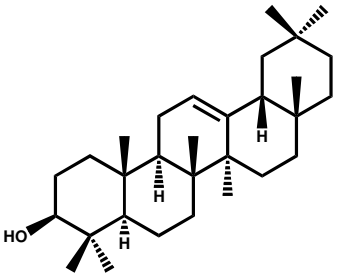
α-Lupeol, **l1**



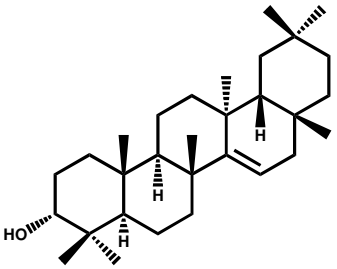
β-Lupeol, **l2**



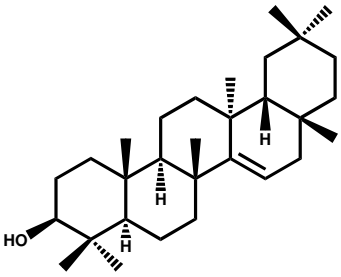
Lupenone, **l3**



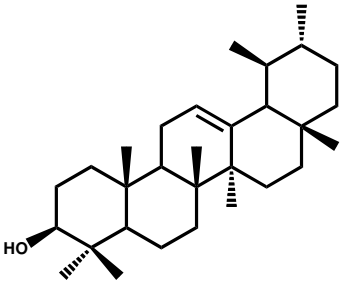
Gymnorhizol, **l4**



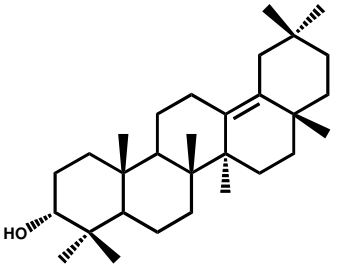
3α-Taraxerol, **l5**



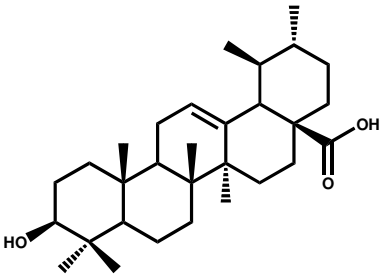
3β-Taraxerol, **l6**



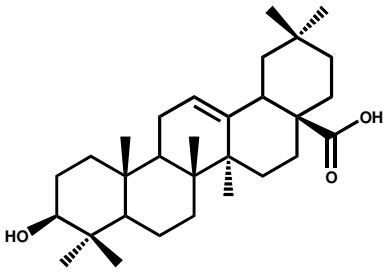
α-Amyrin, **l7**



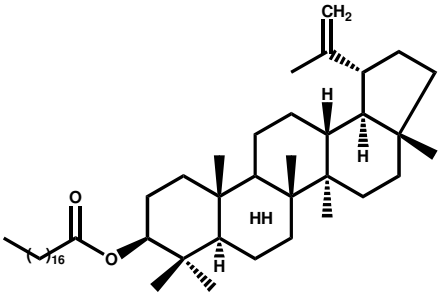
β-Amyrin, **l8**



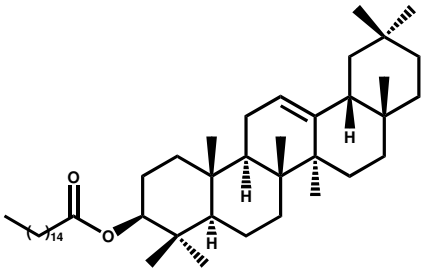
Ursolic acid, **l9**



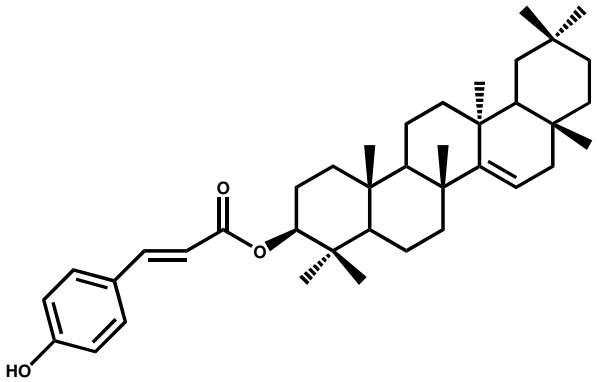
Oleanolic acid, **l10**



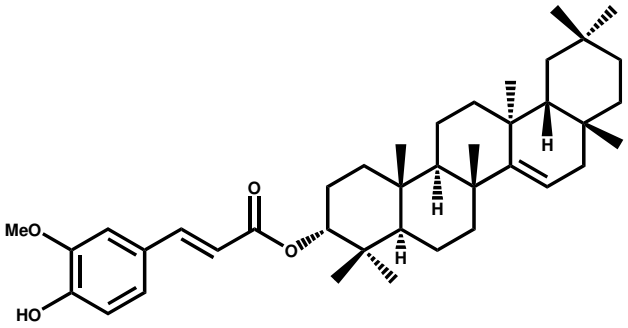
β-Lupeol stearate, **l11**



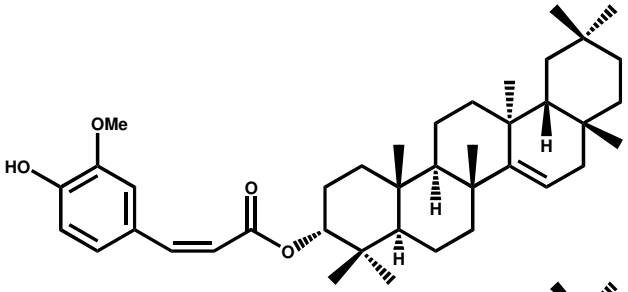
β-Amyrin palmitate, **l12**



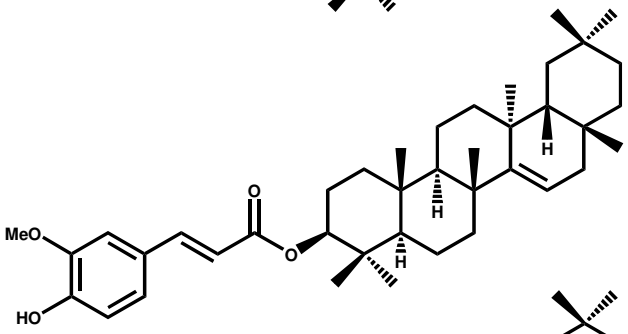
Careaborin, **l13**



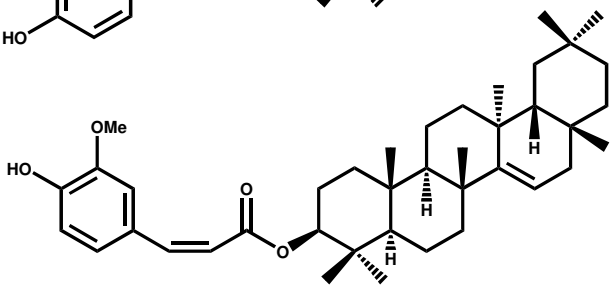
3*α*-*E*-Feruloyltaraxerol, **l14**



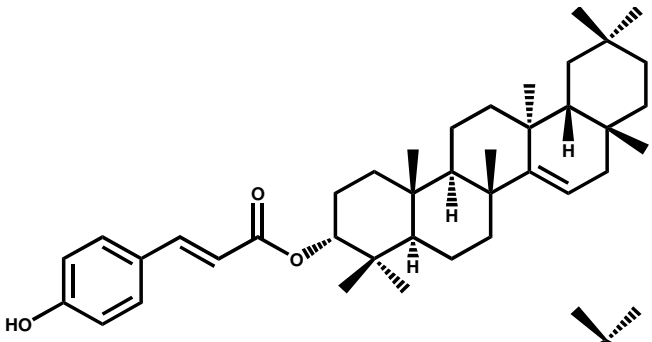
3α-*Z*-Feruloyltaraxerol, **l15**



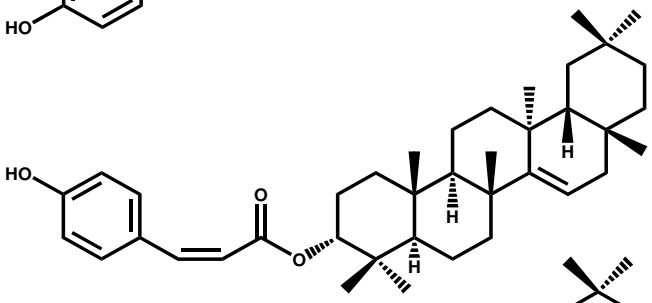
3β-*E*-Feruloyltaraxerol, **l16**



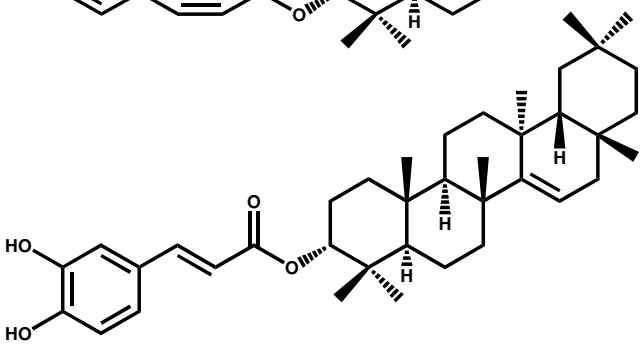
3β-*Z*-Feruloyltaraxerol, **l17**



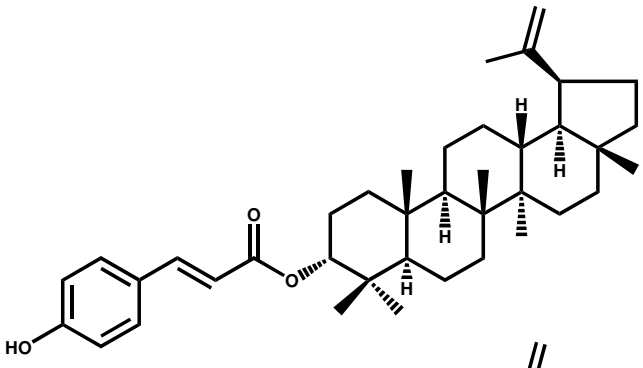
3α-*E*-Coumaroyltaraxerol, **l18**



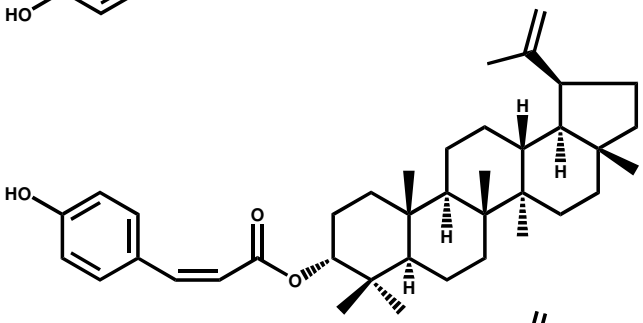
3α-*Z*-Coumaroyltaraxerol, **l19**



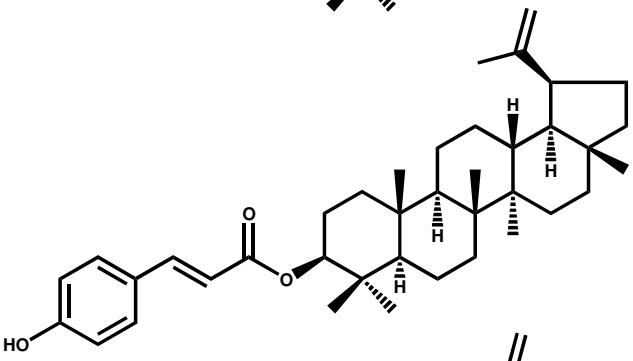
3α-*E*-Caffeoyltaraxerol, **l20**



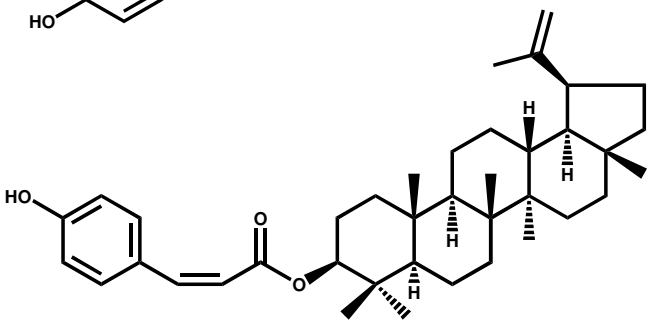
Dioslupesin A, **l21**



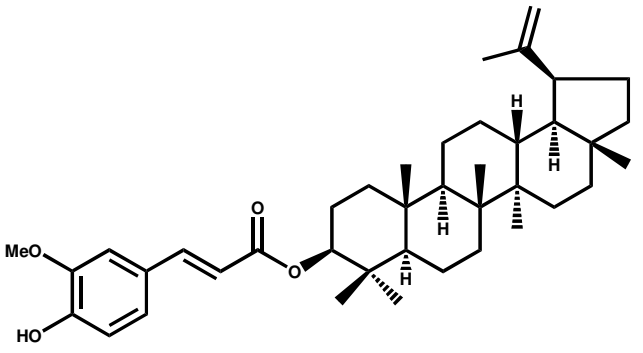
3α-*Z*-Coumaroyllupeol, **l22**



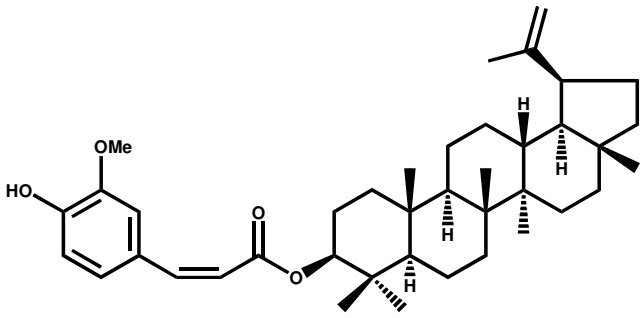
3β-*E*-Coumaroyllupeol, **l23**



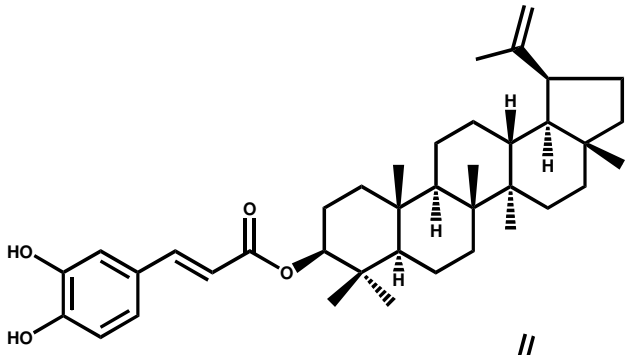
3β-*Z*-Coumaroyllupeol, **l24**



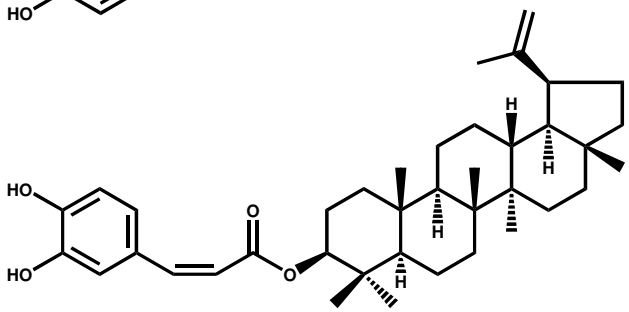
3β-*E*-Feruoyllupeol, **l25**



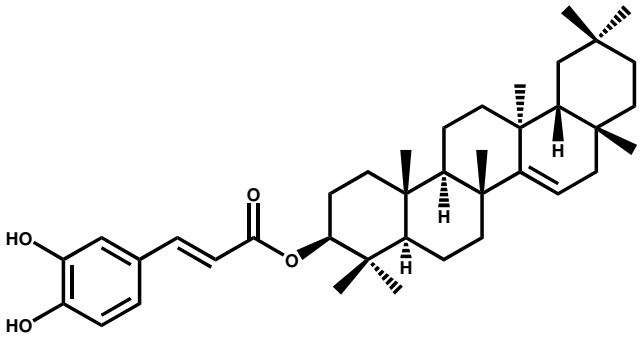
3*β*-*Z*-Feruoyllupeol, **l26**



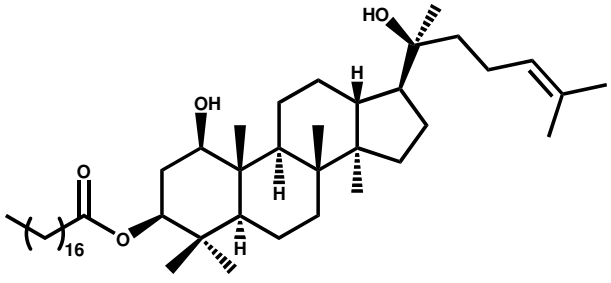
3*β*-*E*-Caffeoyllupeol, **l27**



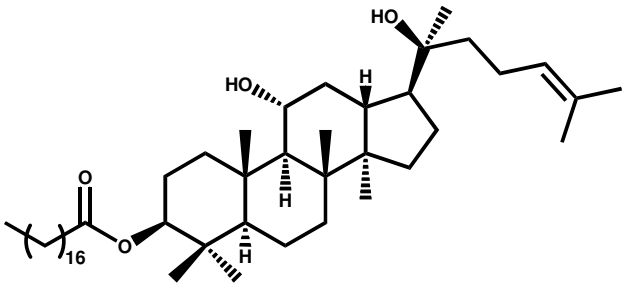
3*β*-*Z*-Caffeoyllupeol, **l28**



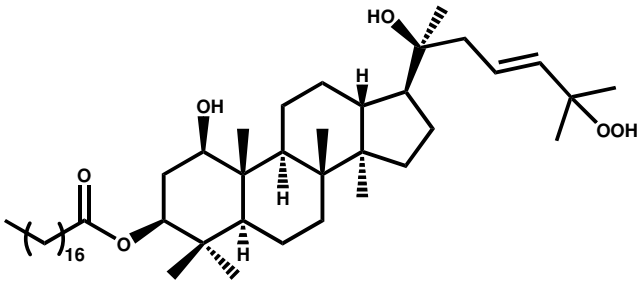
3*β*-*E*-Caffeoyltaraxerol, **l29**



Bruguierin A, **l30**



Bruguierin B, **l31**



Bruguierin C, **l32**

1.3 Objectives

The objectives of this research are as follow:

- to isolate pure compounds from the roots of *B. cylindrica*.
- to determine the structure of pure compounds.
- to evaluate the biological activities of pure compounds.