CHAPTER 1

Introduction

1. 1 Botanical Description (Annonaceae)

1.1.1 *Dasymaschalon yunnanense*

Dasymaschalon yunnanense was found in Thailand and discovered at Doi Tung, Chiang Rai Province, locally known as “Bu-rong Doi”. *D. yunnanense* is evergreen treelet, up to 5 m tall, diameter at breast height 7 cm. Its bark is smooth, mottled grey white and light green (lichen), while the inner bark is dull orange-yellow with darker orange streaks. Flowers have dull yellow fleshy sepals and bright green pedicel with orange hair. Leaves are blades as dark green above and glaucous below. Fruits have bright green with orange tip (Guo *et al*., 2014).

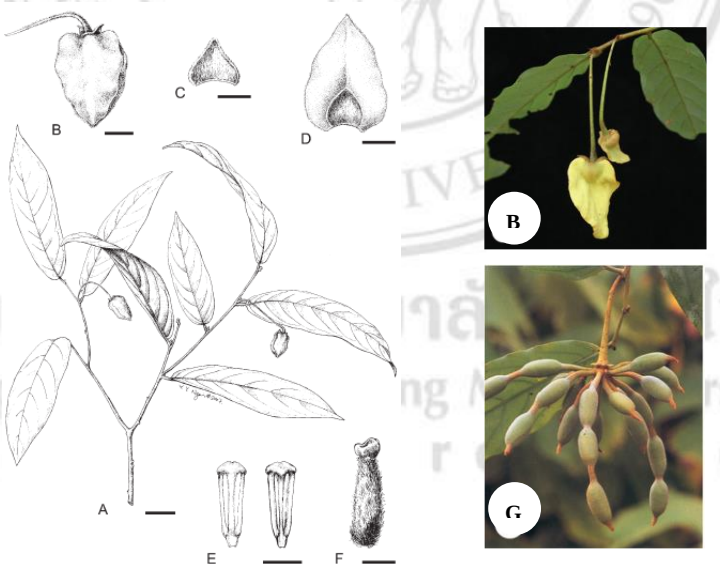


Figure 1.1 *D. yunnanense* sp. nov. A. Flowering branch. B. Flower. C. Sepal (adaxial). D. Petal (adaxial). E. Stamens (abaxial and adaxial). F. Carpel. G. Fruit. Scale bars: A = 3 cm; B, D = 5 mm; C = 2 mm; E, F = 1 mm (Wang *et al*., 2009).

1.1.2 *Miliusa cuneata*

Miliusa cuneata belongs to the family Annonaceae, locally known as “Ra Khang Keaw” in Thai. This plant is a shrub of 2–3 m tall that is mainly distributed in the North of Thailand and Yunnan Province of China. Twigs have brown hair. Leaves are single arrange alternate, spear shape as width 3-4.5 cm, length 9-14 cm, finely hairy on the midribs. Flowers are bright green, inflorescence axillary panicales. Fruits are black round shape, 8-10 mm in diameter, 8-15 per cluster (BGO Plant Database, The Botanical Garden Organization. 2015, accessed on 19/01/15, http://www.qsbg.org/database/botanic_book%20full%20option/search_detail.asp?botanic_id=2574).

Figure 1.2 *M. cuneata* Craib (Flowers, Fruits and Leaves)

1.2 Reviews of Literatures

1.2.1 *Dasymaschalon* Genus

This genus was found about 30 species in Southeast Asia, particularly in Thailand and Malaysia Peninsular. Twelve species, *D. acuminatum, D. angustifolium, D. dasymaschalum, D. echinatum, D. filipes, D. glaucum, D. grandiflorum, D. lomentaceum, D. macrocalyx, D. yunnanense, D. sootepense*, and *D. wallichii* distributed in Thailand (Wang *et al*., 2009). The plants of genus *Dasymaschalon* are traditional Thai medicinal plants that used for tonic, antipyretic and bodily discomfort (Chuakul and Sornthornchareonon, 2003). Previous research reported that this genus showed anticancer activity (Liu *et al*., 1992, Reutrakul *et al*., 2002, Chanakul *et al*., 2011 and Prawat *et al*., 2013). The chemical consitituents of this genus have been reported containing various types of alkaloids, acetogenins, flavonol glycosides and

xanthones. Moreover, it is stated that alkaloids are the major compounds in this genus. The chemical constituents and their biological activities were summarized in **Table 1.1** until 2015.

Table 1.1 Isolated Compounds and Biological Activities from *Dasymaschalon* Genus

Scientific Name (References)	Investigated Part	Compounds	Biological Activities
			Cytotoxicity (ED_{50}, μg/mL)
D. blumei (Chanakul *et al*., 2011)	Stems, Leaves and Twigs	Aristolactam BI (**p3**)	P-388: 11.18 MCF-7: 3.60 Hek 293: inactive
		Goniopedaline (**p6**)	P-388: 2.59 KB: 1.98 MCF-7: 9.45 ASK: 12.76 Hek 293: 17.97
		Griffithinam (**p7**)	P-388: 13.82 Hek 293: inactive
		3,5-Dihydroxy-2,4-dimethoxy aristolactam (**p4**)	P-388: 2.13 KB: 2.97 ASK: 3.04 Hek 293: 14.75
		Oxodiscoguattine (**u6**)	P-388: 0.60 KB: 2.30 Col-2: 0.91 Lu-1: 0.76 Hek 293: 1.60
		Duguevalline (**u2**)	P-388: 9.43 MCF-7: 19.11 Hek 293: inactive

Table 1.1 (Continued)

Scientific Name (References)	Investigated Part	Compounds	Biological Activities
			Cytotoxicity (IC_{50}, μg/mL)
D. dasymaschalum (Prawat *et al*., 2013)	Leaves	3β-Hydroxy-21-*O*-acetyl-24-methylene-cycloartane (**n7**)	KB: 17.80 NCI-H187: 17.54
		3β,21-Dihydroxy-24,31-epoxy-24-methylenecycloartane (**n6**)	KB: 18.21 NCI-H187: 7.82 Antimycobacterial (MIC, mg/mL) H37Ra : 50
			Cytotoxicity (IC_{50}, μg/mL)
		7-Hydroxy-6,8-dimethoxyflavanone (**l3**)	KB: 15.24 BC: 44.60 NCl-H187: 1.85
		2-Hydroxybenzyl benzoate (**c4**)	KB: 25.49 BC: 48.42 NCI-H187: 48.61
		2-Phenyl-2-acetoxyethyl benzoate (**c5**)	NCI-H187: 4.67
		3β-Hydroxy-24-methylenecycloartane (**n10**)	KB: 15.85 BC: 31.65 NCI-H187: 4.67
		3β,21-Dihydroxy-24-methylene-cycloartane (**n9**)	BC: 30.62
		Desmosdumotin B (**m1**)	NCI-H187: 49.74

Table 1.1 (Continued)

Scientific Name (References)	Investigated Part	Compounds	Biological Activities
			Cytotoxicity (IC_{50}, μg/mL)
D. dasymaschalum (Prawat *et al*., 2013)	Leaves	Artabotrene (**c1**)	KB: 31.46 NCI-H187: 18.72
		(−)-Senepoxide (**c7**)	
		(+)-Crotepoxide (**c2**)	KB: 7.44 BC: 32.43 NCI-H187: 6.33
		(−)-1,6-Desoxy-pipoxide (**c3**)	KB: 19.87 BC: 17.76 NCI-H187: 3.07
		Rotundol (**c6**)	
		Cassipourol (**n4**)	KB: 48.83 BC: 30.84 NCI-H187: 15.63
		(+)-Spathulenol (**n15**)	KB: 26.26 NCI-H187: 6.68
D. glaucum (Karntanakrit *et al*., 2011)	Leaves and Twigs	Sinactine (**w2**) Dicentrinone (**u1**) Epiberberine (**s3**) Isoursuline (**q1**)	
D. glaucum (Dai *et al*., 2014)	Leaves and Stems	β-Caryophyllene (**n3**) α-Pinene (**n13**) β-Pinene (**n14**) Bicycloelemene (**n1**)	

Table 1.1 (Continued)

Scientific Name (References)	Investigated Part	Compounds	Biological Activities
D. longiusculum (Dai *et al*., 2014)	Leaves and Stems	*β*-Caryophyllene (**n3**) *α*-Pinene (**n13**) *β*-Pinene (**n14**) *β*-Myrcene (**n12**)	
D. robinsonii (Dai *et al*., 2014)	Leaves and Stems	*β*-Caryophyllene (**n3**) *α*-Copaene (**n5**) Germacrene B (**n11**) *δ*-Cadinene (**n2**)	
D. rostratum (Zhou *et al*., 2001)	-	Lawinal (**l5**) Unonal (**m17**) Isounonal (**m9**) 7-Oxodehydroasimilobine (**u5**)	
D. sootepense (Sinz *et al*., 1998a)	Leaves	(–)-Dasymachaline (**o1**) (–)-Dicentrine (**o2**) (+)-*N*-Methyllaurotetanine (**o6**) Norlaureline (**o8**) *N*-Nornuciferine (**o9**) Sinactine (**w2**) Xylopinine (**w3**) Caseadine (**w1**)	
			Cytotoxicity (ED_{50}, μg/mL)
D. sootepense (Sinz *et al*., 1998b)		Sootepensin A (**a1**) Sootepensin B (**a2**)	L1210: 3×10^{-3} L1210: 3×10^{-4}

Table 1.1 (Continued)

Scientific Name (References)	Investigated Part	Compounds	Biological Activities
			Cytotoxicity (ED_{50}, μg/mL)
D. sootepense (Sinz *et al*., 1998b)	Leaves	Tonkinin C (**a4**)	L1210: 3×10^{-4}
		Tonkinesin C (**a3**)	L1210: 3×10^{-4}
D. sootepense (Sinz *et al*., 1998c)	Leaves	3′-*O*-*α*-L-Rhamnopyranosyl-(1→2)-*β*-D-glucopyranoside (**m11**) 3′-*O*-*α*-L-Rhamnopyranosyl-(1→2)-*O*-*α*-L-rhamnopyranosyl-(1→6)-*β*-D-glucopyranoside (**m15**)	
D. sootepense (Reutrakul *et al*., 2002)	Leaves	Sootepenseone (**b1**)	
D. sootepense (Hongthong *et al*., 2008)	Leaves and Twigs	Sinactine (**w2**) 7-Hydroxydehydrodicentrine (**o13**) Dicentrinone (**u1**) Nordicentrine (**o7**) Aristolactam AII (**p2**) Epiberberine (**s3**)	
D. trichophorum (Liu *et al*., 1992)	Stems and Leaves	Dasytrichone (**m1**)	-43% on B[a]P metabolism at 20 μg/mL

Table 1.1 (Continued)

Scientific Name (References)	Investigated Part	Compounds	Biological Activities
D. trichophorum (Zhou *et al*., 2013a)	Stems	10-Amino-3,6-dihydroxy-2,4-dimethoxy phenanthrene-1-carboxylic acid lactam (**p1**) Enterocarpam-II (**p5**) Oldhamactam (**p8**) Goniopedaline (**p6**) Stigmalactam (**p9**)	
D. trichophorum (Zhou *et al*., 2013b)	Rhizome	Dasytrichone (**m1**) 5-Methoxydasytrichone (**m2**) (−)-Epicatechin (**k1**) 3,4,5-Trimethoxyphenol-*β-D*-glucopyranoside (**i2**) *trans-N*-Caffeoyltyramine (**v1**) 1',4-Dihydroxy-3,3',5'-trimethoxy-8,4'-oxyneoligna-7,9-diol (**h4**) Resveratrol (**i1**) Naringetol (**l4**) Dihydrokaempferol (**l1**) Eriodictyol (**l2**)	
D. obtusipetalum (Rattanawijit *et al*., 2013)	Leaves	(−)-Dicentrine (**o2**)	AChE: 100 ng BSL: LC_{50} 57 µg/mL

1.2.2 *Miliusa* Genus

The genus *Miliusa* (Annonaceae) consists of approximately 40 species which distributed in tropical rainforest of North Thailand, India, South China and North Australia (Chaowasku *et al*., 2008). *Miliusa* plants have been used as Thai traditional medicines such as tonic, aphrodisiac (Chuakul *et al*., 2003), gastropathy and glomerulonephropathy (Kamperdick *et al*., 2002). The plants belonging to this genus were reported to contain homogentisic acid derivatives, flavonoids, dihydrochalcones, neolignans, lignans and alkaloids. Several compounds exhibited cytotoxic (Huong *et al*., 2004, Thuy *et al*., 2011, Sawasdee *et al*., 2013a, Sawasdee *et al*., 2013b and Naphong *et al*., 2013) and antiviral (Sawasdee *et al*., 2013a and Sawasdee *et al*., 2014) activities. The chemical constituents from this genus and their biological activities were summarized in **Table 1.2** until end of 2015.

Table 1.2 Isolated Compounds and Biological Activities from *Miliusa* Genus

Scientific Name (References)	Investigated Part	Compounds	Biological Activities	
			Cytotoxicity (IC_{50}, μg/mL)	
M. balansae (Huong *et al*., 2004)	Leaves and Branches	Miliufavol (**m10**)		
		Ombuine (**m12**)	KB:	> 5
			Hep-G2:	1.5
			RD:	> 5
		Chrysosplenol B (**m4**)	KB:	4.6
			Hep-G2:	0.93
			RD:	> 5
		Pachypodol (**m13**)	KB:	0.7
			Hep-G2:	0.55
			RD:	3.01
		Chrysosplenol C (**m5**)	KB:	4.3
			Hep-G2:	0.57
			RD:	2.09

Table 1.2 (Continued)

Scientific Name (References)	Investigated Part	Compounds	Biological Activities
M. cuneata (Chen *et al*., 2003)	Stems and Leaves	2,10-Dimethoxy-3,11-dihydroxy-5,6-dihydroprotoberberine (**s1**) Pseudocolumbamine (**s2**) *N*-Methyllindcarpine (**o5**) (+)-Liriotulipiferine (**o4**) *N*,*O*-Dimethylhernovine (**o3**) Dehydroxylopine (**o12**) (–)-Nordicentrine (**o7**) Wilsonirine (**o11**) Norisocorytuberine (**o10**) Salutarine (**t1**) Kinabaline (**q2**) *N*-Methylcorydaldine (**r1**) Liriodenine (**u4**) Lanuginosine (**u3**) 1,9-Dihydroxy-2,11-dimethoxy-4,5-dihydro-7-Oxoaporphine (**u7**)	
M. fragrans (Sawasdee *et al*., 2013a)	Leaves and Stems	(+)-3-*O*-Demethyleu-siderin C (**d4**)	Cytotoxicity (IC_{50}, μg/mL) KB: 20.3 MCF-7: 22.1 NCI-H187: 17.1
		(+)-4-*O*-Demethyleu-siderin C (**d5**)	KB: 17.9 MCF-7: 28.4 NCI-H187: 15.9

Table 1.2 (Continued)

Scientific Name (References)	Investigated Part	Compounds	Biological Activities
			Cytotoxicity (IC_{50}, μg/mL)
M. fragrans (Sawasdee *et al*., 2013a)	Leaves and Stems	(+)-4-*O*-Demethyleusiderin C (**d5**)	Vero cell: 150 HSV-1: 62.5 HSV-2: 87.5
		(–)-Eusiderin A (**d1**) Eusiderin C (**d2**)	
		Eusiderin D (**d3**)	KB: 18.4 MCF-7: 22.6 NCI-H187: 20.6
		(–)-Miliusfragrin (**d6**)	KB: 23.8 MCF-7: 24.4 NCI-H187: 16.7
		(–)-4-*O*-Methylmiliusfragrin (**d7**)	
		(7*S*,8*R*)-7-Hydroxy-3,4,3'-trimethoxy-$\Delta^{1,3,5,1',3',5',8'}$-8.*O*.4'-neolignan (**h5**)	KB: 14.4 MCF-7: 13.0 NCI-H187: 12.7
		(–)-Epicatechin (**k1**)	KB: > 50 MCF-7: > 50 NCI-H187: > 50
		(–)-Miliusfragranol A (**h2**) (–)-Miliufrasgranol B (**h3**) 2-(4-Allyl-2,6-dimethoxy phenoxy)-1-(3,4-dimethoxyphenyl) propane (**h1**)	

Table 1.2 (Continued)

Scientific Name (References)	Investigated Part	Compounds	Biological Activities
M. fragrans (Sawasdee *et al*., 2013a)	Leaves and Stems	Virolongin B (**h7**)	
			Cytotoxicity (IC_{50}, μg/mL)
		Licarin A (**e2**)	KB: 12.9 MCF-7: 45.6 NCI-H187: 16.7 Vero cell: 150 HSV-1: 66.7 HSV-2: 87.5
		(+)-3-Hydroxy-veraguensin (**f1**) (7*S*,8*S*,7'*S*,8'*S*)-3,4,5,3',4'-Penta-methoxy-7,7'-epoxylignan (**f2**) Veraguensin (**f3**)	
			Cytotoxicity (μM)
M. mollis (Sawasdee *et al*., 2013b)	Leaves	Decurrenal (**e1**)	KB: 137 MCF-7: 169 NCI-H187: 94.7
		Miliumollin (**e3**)	KB: 27.2 MCF-7: 71.9 NCI-H187: 95.3
		3'-Methoxy-miliumollin (**e4**)	KB: 31.4 MCF-7: 56.2 NCI-H187: 61.3
		4'-*O*-Methylmiliu-mollin (**e5**)	

Table 1.2 (Continued)

Scientific Name (References)	Investigated Part	Compounds	Biological Activities
M. mollis (Sawasdee *et al*., 2013b)	Leaves	7-Methoxymiliumollin (**e6**)	
		Miliumollinone (**e7**)	Cytotoxicity (μM) KB: 95.9 MCF-7: 143 NCI-H187: 116
		Miliusamollin (**h6**)	
M. sinensis (Thuy *et al*., 2011)	Leaves and Branches	4', 6'-Dihydroxy-2',3',4-trimethoxydihydrochal-cone (**j1**)	Cytotoxicity (IC_{50}, μg/mL) MCF-7: > 128 Lu-1: > 128 Hep-G2: > 128 KB: > 128
		Dihydropashanone (**j2**) Pashanone (**j3**) Pinostrobin (**l9**) 5-Hydroxy-7,4′-dimethoxyflavanone (**l6**) 5-Hydroxy-6,7-dimethoxyflavanone (**l7**) 5-Hydroxy-7,8-dimethoxyflavanone (**l8**) 24-Methylen-cycloartane-3β,21-diol (**n8**)	

Table 1.2 (Continued)

Scientific Name (References)	Investigated Part	Compounds	Biological Activities
			Cytotoxicity (IC_{50}, μg/mL)
M. sinensis (Thuy *et al*., 2011)	Leaves and Branches	Liriodenine (**u4**)	MCF-7: 2.89 Lu-1: 6.66 Hep-G2: 5.23 KB: 2.30
		3,5-Dihydroxy-7,3′,4′-trimethoxyflavone (**m7**)	MCF-7: > 128 Lu-1: > 128 Hep-G2: > 128 KB: > 128
			Cytotoxicity (ED_{50}, μg/mL)
M. smithiae (Naphong *et al*., 2013)	Leaves and Twigs	5,3'-Dihydroxy-3,7,4'-trimethoxyflavone (**m3**)	P-388: 3.6 KB: > 20 Col-2: 0.76 MCF-7: 0.68 Lu-1: > 20 T24: > 20 ASK: 16.08 Hek293: 2.81
		5-Hydroxy-3,7,4'-trimethoxyflavone (**m8**)	
M. umpangensis (Sawasdee *et al*., 2014)	Leaves	Methyl 2-(1' β-geranyl-5'*β*-hydroxy-2'- oxo-cyclohex-3'-enyl)acetate (**g1**) (+)-Miliusane I (**g2**) (+)-Miliusate (**g3**) (+)-Miliusol (**g4**)	

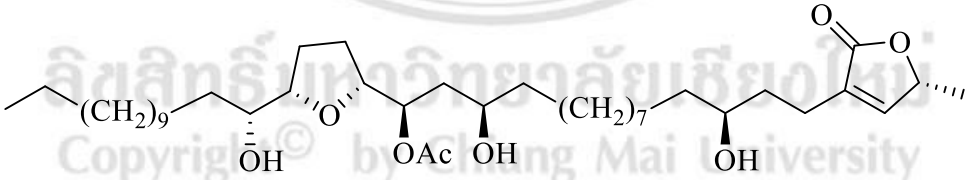
Table 1.2 (Continued)

Scientific Name (References)	Investigated Part	Compounds	Biological Activities
M. umpangensis (Sawasdee *et al*., 2014)	Leaves	Ayanin (**m3**)	
		7, 3', 4'-Trimethyl-quercetin (**m7**)	
		Ombuine (**m12**)	
			Cytotoxicity IC_{50} (μM)
		3,7-Dimethylether quercetin (**m14**)	HSV-1: 94.7 HSV-2: 189.5
		Chrysosplenol D (**m6**)	HSV-1: 86.8 HSV-2: 86.7
		Rutin (**m16**)	

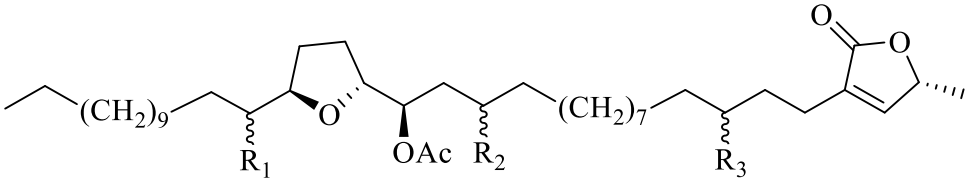
1.2.3 The Chemical Structures from *Dasymaschalon* and *Miliusa* genera

1.2.3.1 Malonate or Acetate Pathway

a) Acetogenins



Sootepensin A (**a1**)

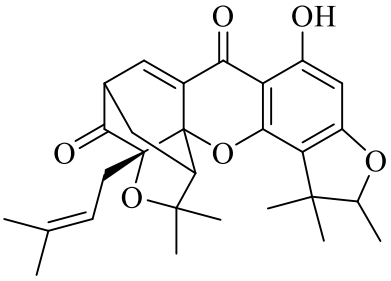


R_1 = ····OH , R_2 = ▬OH , R_3 = C=O ; Sootepensin B (**a2**)

R_1 = ▬OH , R_2 = ····OH, R_3 = ▬OH ; Tonkinesin C (**a3**)

R_1 = ▬OH , R_2 = ····OH, R_3 = C=O ; Tonkinin C (**a4**)

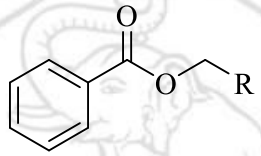
b) Xanthone

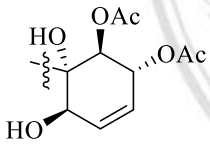


Sootepenseone (**b1**)

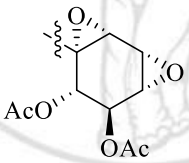
1.2.3.2 Shikimate Pathway

c) Benzoate Derivatives

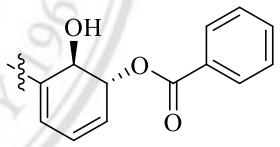


R =  ;

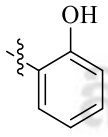
Artabotrene (**c1**)

R =  ;

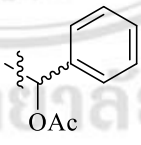
(+)-Crotepoxide (**c2**)

R =  ;

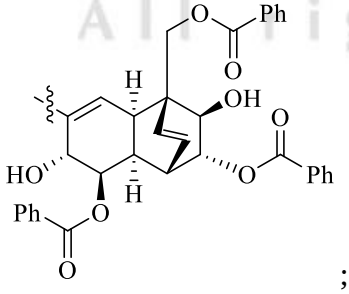
(–)-1,6-Desoxypipoxide (**c3**)

R =  ;

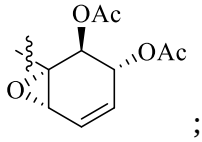
2-Hydroxybenzyl benzoate (**c4**)

R =  ;

2-Phenyl-2-acetoxyethyl benzoate (**c5**)

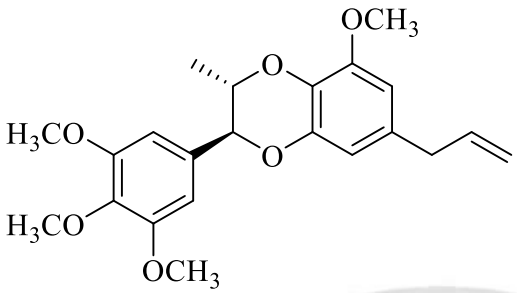
R =  ;

Rotundol (**c6**)

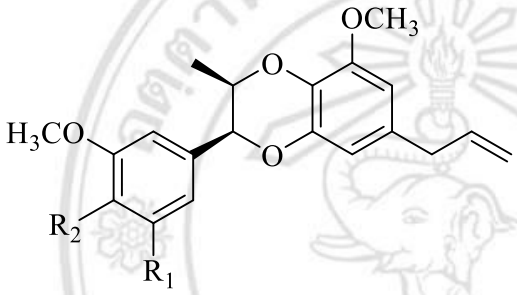
R =  ;

(–)-Senepoxide (**c7**)

d) Benzodioxane Neolignans



(–)-Eusiderin A (**d1**)

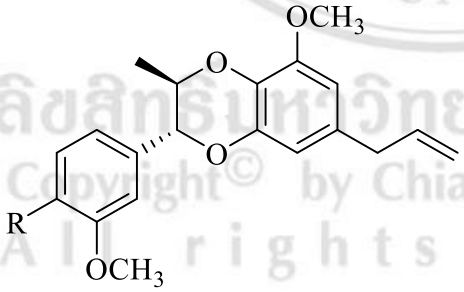


$R_1 = R_2 = OCH_3$; Eusiderin C (**d2**)

$R_1 = H$, $R_2 = OCH_3$; Eusiderin D (**d3**)

$R_1 = OH$, $R_2 = OCH_3$; (+)-3-*O*-Demethyleusiderin C (**d4**)

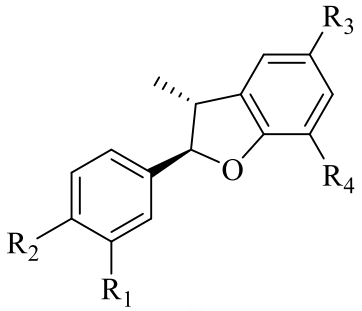
$R_1 = OCH_3$, $R_2 = OH$; (+)-4-*O*-Demethyleusiderin C (**d5**)

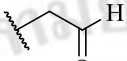


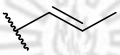
R = OH; (–)-Miliusfragrin (**d6**)

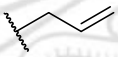
R = OCH_3; (–)-4-*O*-Methylmiliusfragrin (**d7**)

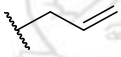
e) Dihydrobenzofuran Neolignans

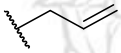


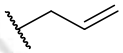
$R_1 = R_4 = H$, $R_2 = OH$, $R_3 =$  ; Decurrenal (**e1**)

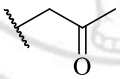
$R_1 = R_4 = OCH_3$, $R_2 = OH$, $R_3 =$  ; Licarin A (**e2**)

$R_1 = R_4 = H$, $R_2 = OH$, $R_3 =$  ; Miliumollin (**e3**)

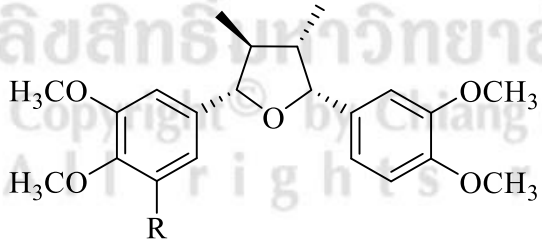
$R_1 = OCH_3$, $R_2 = OH$, $R_3 =$  , $R_4 = H$; 3'-Methoxymiliumollin (**e4**)

$R_1 = R_4 = H$, $R_2 = OCH_3$, $R_3 =$  ; 4'-*O*-Methylmiliumollin (**e5**)

$R_1 = H$, $R_2 = OH$, $R_3 =$  , $R_4 = OCH_3$; 7-Methoxymiliumollin (**e6**)

$R_1 = R_4 = H$, $R_2 = OH$, $R_3 =$  ; Miliumollinone (**e7**)

f) Epoxylignans

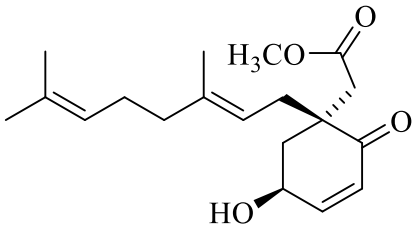


R = OH; (+)-3-Hydroxyveraguensin (**f1**)

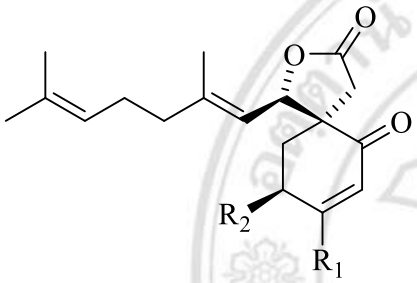
R = OCH_3; (7*S*,8*S*,7'*S*,8'*S*)-3,4,5,3',4'-Pentamethoxy-7,7'-epoxylignan (**f2**)

R = H; Veraguensin (**f3**)

g) Geranylated Homogentisic Acid Derivatives



Methyl 2-(1'*β*-geranyl-5'*β*-hydroxy-
2'-oxocyclohex-3'-enyl) acetate (**g1**)

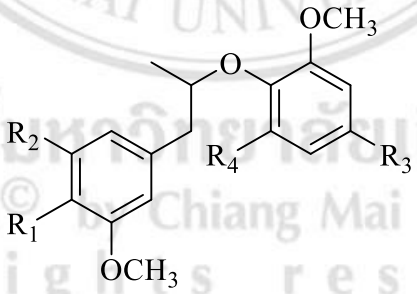


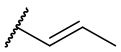
R_1 = OCH_3, R_2 = OH; (+)-Miliusane I (**g2**)

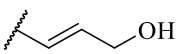
R_1 = H, R_2 = OAc; (+)-Miliusate (**g3**)

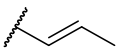
R_1 = H, R_2 = OH; (+)-Miliusol (**g4**)

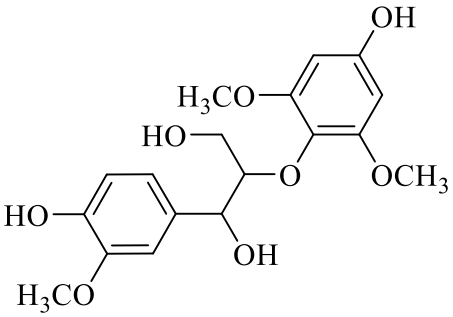
h) Oxyneolignanes



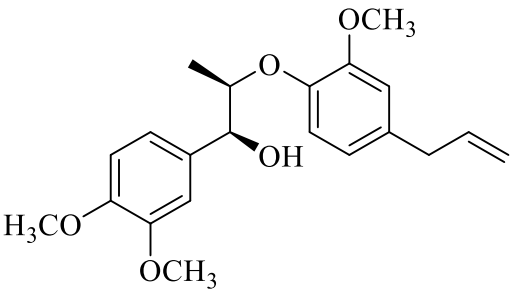
R_1 = R_4 = OCH_3, R_2 = H, R_3 =  ; 2-(4-Allyl-2,6-dimethoxyphenoxy)-
1-(3,4-dimethoxyphenyl)propane (**h1**)

R_1 = OCH_3, R_2 = H, R_3 =  , R_4 = OCH_3; (–)-Miliusfragranol A (**h2**)

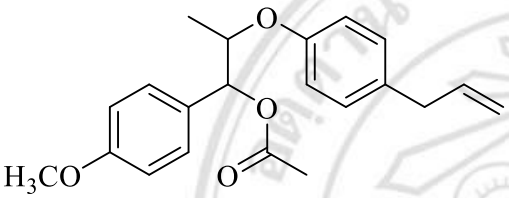
R_1 = OH, R_2 = H, R_3 =  , R_4 = H; (–)-Miliusfragranol B (**h3**)



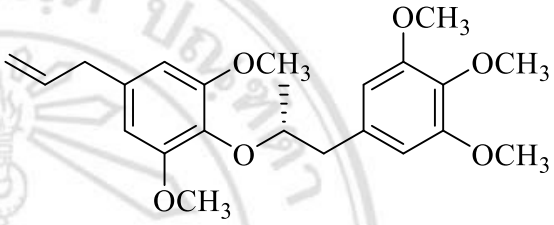
1',4-Dihydroxy-3,3',5'-trimethoxy-8,4'-oxyneoligna-7,9-diol (**h4**)



(7*S*,8*R*)-7-Hydroxy-3,4,3'- trimethoxy-$\Delta^{1,3,5,1',3',5',8'}$-8.*O*.4'-neolignan (**h5**)

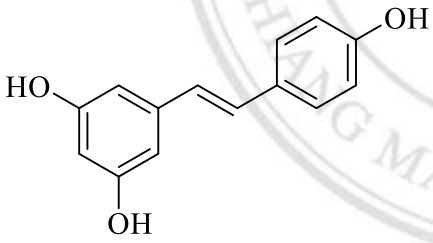


Miliusamollin (**h6**)

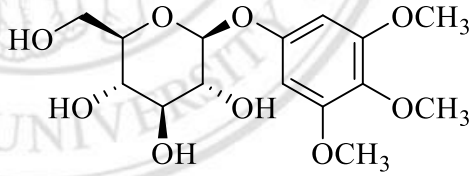


Virolongin B (**h7**)

i) Phenolic Compounds



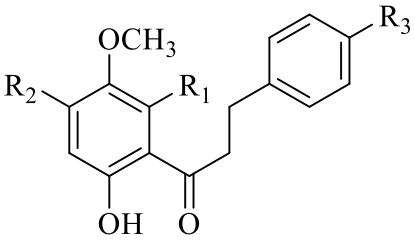
Resveratrol (**i1**)



3,4,5-Trimethoxyphenol-*β*-D-glucopyranoside (**i2**)

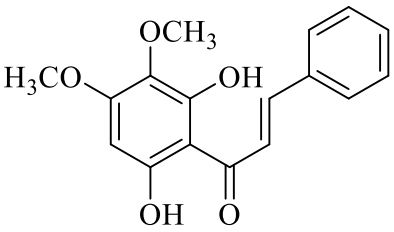
1.2.3.3 Acetate / Shikimate

j) Chalcones



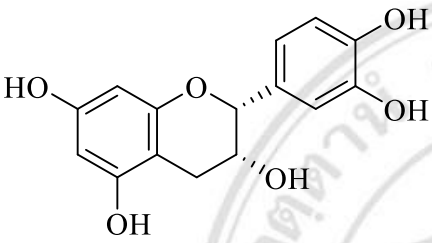
R_1 = OCH_3, R_2 = OH, R_3 = OCH_3;
4′, 6′-Dihydroxy-2′,3′,4-trimethoxy dihydrochalcone (**j1**)

R_1 = OH, R_2 = OCH_3, R_3 = H;
Dihydropashanone (**j2**)



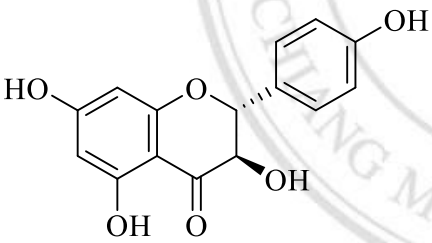
Pashanone (**j3**)

k) Flavan

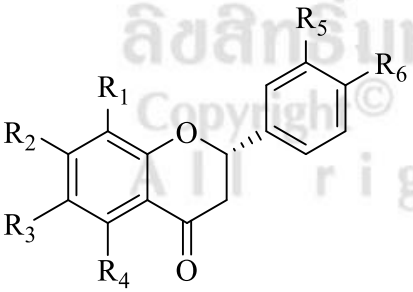


(−)-Epicatechin (**k1**)

l) Flavanones



Dihydrokaempferol (**l1**)



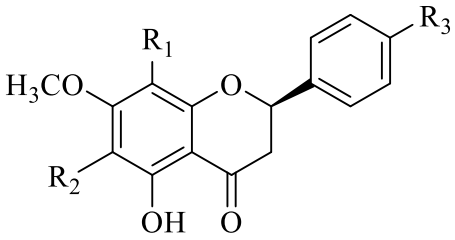
$R_1 = R_3 = H$, $H_2 = R_4 = R_5 = H_6 = OH$; Eriodictyol (**l2**)

$R_1 = OCH_3$, $R_2 = OH$, $R_3 = OCH_3$, $R_4 = R_5 = R_6 = H$;

7-Hydroxy-6,8-dimethoxy flavanone (**l3**)

$R_1 = R_3 = R_5 = H$, $H_2 = R_4 = H_6 = OH$; Naringetol (**l4**)

$R_1 = CHO$, $R_2 = R_4 = OH$, $R_3 = CH_3$, $R_5 = R_6 = H$; Lawinal (**l5**)



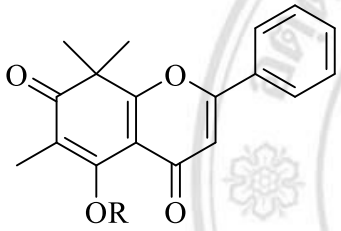
$R_1 = R_2 = H$, $R_3 = OCH_3$; 5-Hydroxy-7,4′-dimethoxyflavanone (**l6**)

$R_1 = OCH_3$, $R_2 = R_3 = H$; 5-Hydroxy-6,7-dimethoxyflavanone (**l7**)

$R_1 = R_3 = H$, $R_2 = OCH_3$; 5-Hydroxy-7,8-dimethoxyflavanone (**l8**)

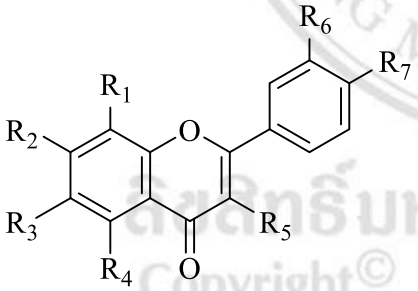
$R_1 = R_2 = R_3 = H$; Pinostrobin (**l9**)

m) Flavones



R = H; Dasytrichone (**m1**)

R = CH_3; 5-Methoxydasytrichone (**m2**)



$R_1 = R_3 = H$, $R_2 = R_5 = R_7 = OCH_3$, $R_4 = R_6 = OH$;

5,3'-Dihydroxy-3,7,4'-trimethoxyflavone or Ayanin (**m3**)

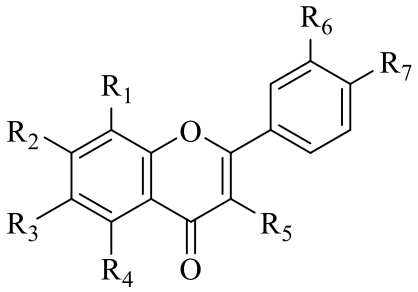
$R_1 = H$, $R_2 = R_3 = R_5 = R_6 = OCH_3$, $R_4 = R_7 = OH$; Chrysosplenol B (**m4**)

$R_1 = H$, $R_2 = R_5 = R_6 = OCH_3$, $R_3 = R_4 = R_7 = OH$; Chrysosplenol C (**m5**)

$R_1 = H$, $R_2 = R_3 = R_5 = OCH_3$, $R_4 = R_6 = R_7 = OH$; Chrysosplenol D (**m6**)

$R_1 = R_3 = H$, $R_2 = R_6 = R_7 = OCH_3$, $R_4 = R_5 = OH$;

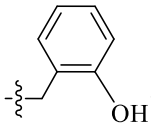
3,5-Dihydroxy-7,3′,4′-trimethoxyflavone or 7,3′,4′-Trimethylquercetin (**m7**)

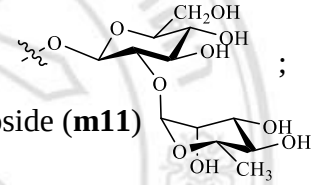


$R_1 = R_3 = R_6 = H$, $R_2 = R_5 = R_7 = OCH_3$, $R_4 = OH$;

5-Hydroxy-3,7,4'-trimethoxyflavone (**m8**)

$R_1 = CHO$, $R_2 = R_4 = OH$, $R_3 = CH_3$, $R_5 = R_6 = R_7 = H$; Isounonal (**m9**)

$R_1 =$  , $R_2 = R_5 = R_6 = OCH_3$, $R_3 = H$, $R_4 = R_7 = OH$; Miliufavol (**m10**)

$R_1 = R_3 = H$, $R_2 = R_5 = OCH_3$, $R_4 = R_7 = OH$, $R_6 =$  ;

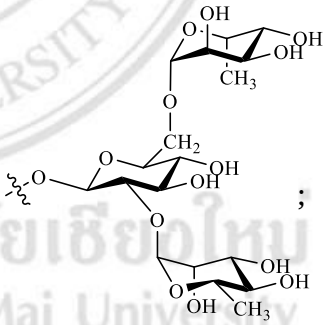
3′-*O*-*α*-L-Rhamnopyranosyl-(1→2)-*β*-D-glucopyranoside (**m11**)

$R_1 = R_3 = H$, $R_2 = R_7 = OCH_3$, $R_4 = R_5 = R_6 = OH$; Ombuine (**m12**)

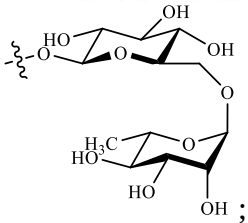
$R_1 =$ $R_3 = H$, $R_2 = R_5 = R_6 = OCH_3$, $R_4 = R_7 = OH$; Pachypodol (**m13**)

$R_1 = R_3 = H$, $R_2 = R_5 = OCH_3$, $R_4 = R_6 = R_7 = OH$;

3,7-Dimethylether quercetin (**m14**)

$R_1 = R_3 = H$, $R_2 = R_5 = OCH_3$, $R_4 = R_7 = OH$, $R_6 =$  ;

3′-*O*-*α*-L-Rhamnopyranosyl- (1→2)-*O*-*α*-L-rhamno-pyranosyl-(1→6)-*β*-D-glucopyranoside (**m15**)

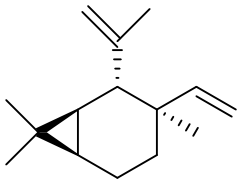


$R_1 = R_3 = H$, $R_2 = R_4 = R_6 = R_7 = OH$, $R_5 =$; Rutin (**m16**)

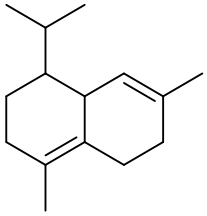
$R_1 = CH_3$, $R_2 = R_4 = OH$, $R_3 = CHO$, $R_5 = R_6 = R_7 = H$; Unonal (**m17**)

1.2.3.4 Mevalonate Pathway

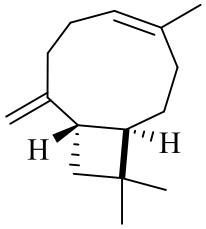
n) Terpenoids



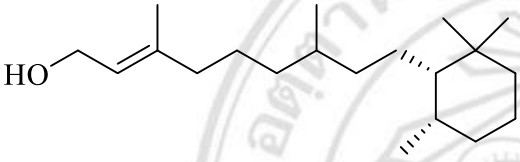
Bicycloelemen (**n1**)



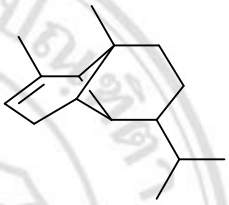
δ-Cadinene (**n2**)



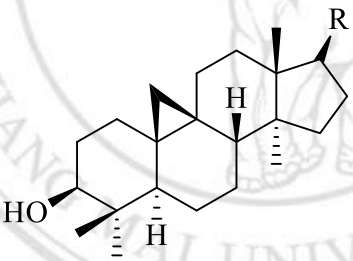
β-Caryophyllene (**n3**)

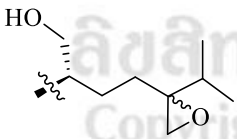


Cassipourol (**n4**)

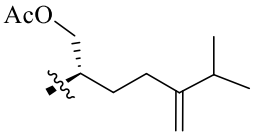


α-Copaene (**n5**)

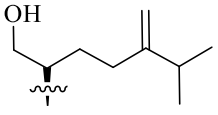


R = 

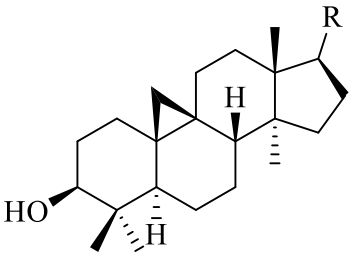
; 3*β*,21-Dihydroxy-24,31-epoxy-24-methylenecycloartane (**n6**)

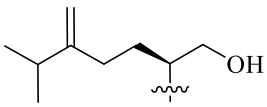
R = 

; 3*β*-Hydroxy-21-*O*-acetyl-24-methylenecycloartane (**n7**)

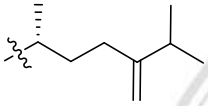
R = 

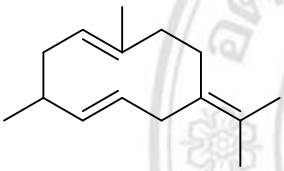
; 24-Methylencycloartane-3*β*,21-diol (**n8**)



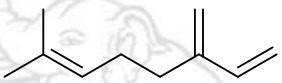
R = 

; 3*β*, 21-Dihydroxy-24-methylene cycloartane (**n9**)

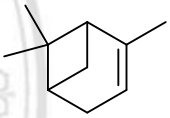
R =  ; 3*β*-Hydroxy-24-methylene cycloartane (**n10**)



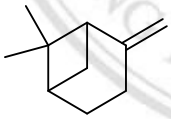
Germacrene B (**n11**)



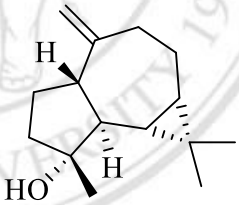
β-Myrcene (**n12**)



α-Pinene (**n13**)



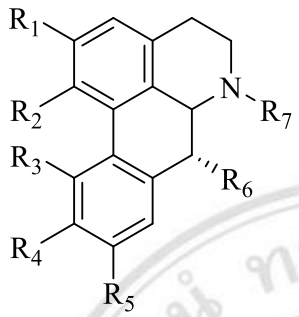
β-Pinene **(n14)**



(+)-Spathulenol (**n15**)

1.2.3.5 Alkaloid Pathway

o) Aporphine Alkaloids



$R_1 = R_2 = –OCH_2O–$, $R_3 = H$, $R_4 = R_5 = OCH_3$, $R_6 = OH$, $R_7 = CH_3$;

(–)-Dasymachaline (**o1**)

$R_1 = R_2 = –OCH_2O–$, $R_4 = R_5 = OCH_3$, $R_3 = R_6 = H$, $R_7 = CH_3$;

(–)-Dicentrine (**o2**)

$R_1 = OH$, $R_2 = R_3 = R_4 = OCH_3$, $R_5 = R_6 = H$, $R_7 = CH_3$;

N,O-Dimethylhernovine (**o3**)

$R_1 = OH$, $R_2 = OCH_3$, $R_3 = R_6 = H$, $R_4 = OH$, $R_5 = OCH_3$, $R_7 = CH_3$;

(+)-Liriotulipiferine (**o4**)

$R_1 = OH$, $R_2 = R_4 = OCH_3$, $R_3 = OH$, $R_5 = R_6 = H$, $R_7 = CH_3$;

N-Methyllindcarpine (**o5**)

$R_1 = R_2 = OCH_3$, $R_4 = OCH_3$, $R_5 = OH$, $R_3 = R_6 = H$, $R_7 = CH_3$;

(+)-*N*-methyllaurotetanine (**o6**)

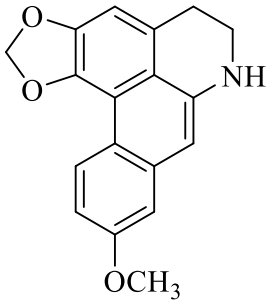
$R_1 = R_2 = –OCH_2O–$, $R_4 = R_5 = OCH_3$, $R_3 = R_6 = R_7 = H$; (–)-Nordicentrine (**o7**)

$R_1 = R_2 = –OCH_2O–$, $R_4 = OCH_3$, $R_3 = R_5 = R_6 = R_7 = H$; Norlaureline (**o8**)

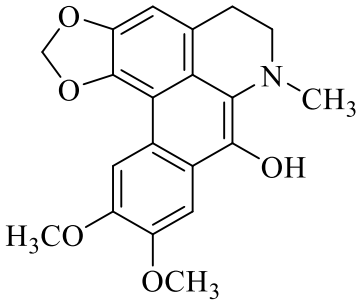
$R_1 = R_2 = OCH_3$, $R_3 = R_4 = R_5 = R_6 = R_7 = H$; *N*-Nornuciferine (**o9**)

$R_1 = R_4 = OCH_3$, $R_2 = R_5 = OH$, $R_3 = R_6 = R_7 = H$; Norisocorytuberine (**o10**)

$R_1 = R_4 = R_5 = OCH_3$, $R_2 = OH$, $R_3 = R_6 = R_7 = H$; Wilsonirine (**o11**)

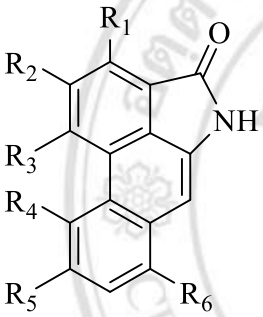


Dehydroxylopine (**o12**)



7-Hydroxydehydrodicentrine (**o13**)

p) Aristolactam Alkaloids



$R_1 = R_3 = OCH_3$, $R_2 = R_5 = OH$, $R_4 = R_6 = H$; 10-Amino-3, 6-dihydroxy-2,4-dimethoxy-phenanthrene-1-carboxylic acid lactam (**p1**)

$R_1 = R_4 = R_5 = R_6 = H$, $R_2 = OH$, $R_3 = OCH_3$; Aristolactam AII (**p2**)

$R_1 = R_4 = R_5 = H$, $R_2 = R_3 = R_6 = OCH_3$; Aristolactam BI (**p3**)

$R_1 = R_3 = OCH_3$, $R_2 = R_4 = OH$, $R_5 = R_6 = H$; 3,5-Dihydroxy-2,4-dimethoxyaristolactam (**p4**)

$R_1 = R_4 = R_5 = H$, $R_2 = OH$, $R_3 = R_6 = OCH_3$; Enterocarpam-II (**p5**)

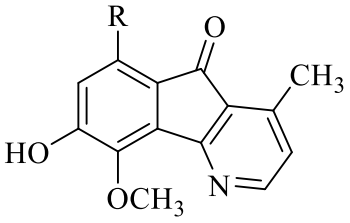
$R_1 = R_3 = OCH_3$, $R_2 = OH$, $R_4 = R_5 = R_6 = H$; Goniopedaline (**p6**)

$R_1 = R_4 = R_5 = H$, $R_2 = OCH_3$, $R_3 = OH$, $R_6 = OCH_3$; Griffithinam (**p7**)

$R_1 = R_2 = R_3 = OCH_3$, $R_4 = R_5 = H$, $R_6 = OH$; Oldhamactam (**p8**)

$R_1 = R_2 = R_3 = OCH_3$, $R_4 = R_6 = H$, $R_5 = OH$; Stigmalactam (**p9**)

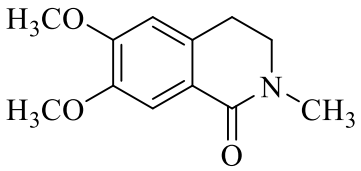
q) Azafluorene Alkaloids



R = H; Isoursuline (**q1**)

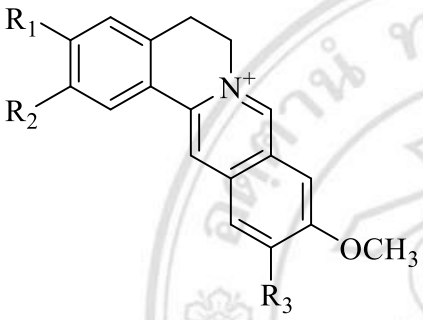
R = OCH_3; Kinabaline (**q2**)

r) Dihydroisoquinolinone Alkaloid



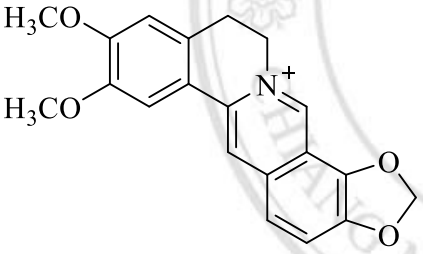
N-Methylcorydaldine (**r1**)

s) Dihydroprotoberberine Alkaloids



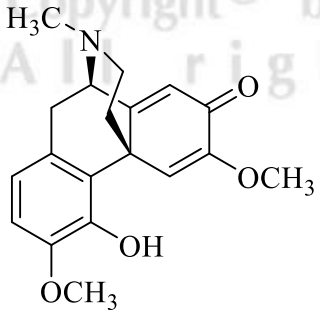
$R_1 = R_3 = OH$, $R_2 = OCH_3$;
2,10-Dimethoxy-3,11-dihydroxy-5,6-dihydroprotoberberine (**s1**)

$R_1 = R_3 = OCH_3$, $R_2 = OH$;
Pseudocolumbamine (**s2**)



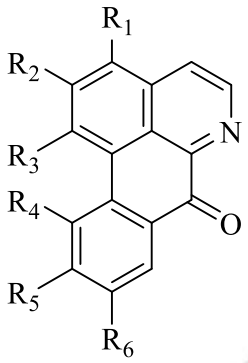
Epiberberine (**s3**)

t) Morphinane Alkaloid



Salutarine (**t1**)

u) Oxoaporphine Alkaloids



$R_1 = R_4 = H$, $R_2 = R_3 = –OCH_2O–$, $R_5 = R_6 = OCH_3$; Dicentrinone (**u1**)

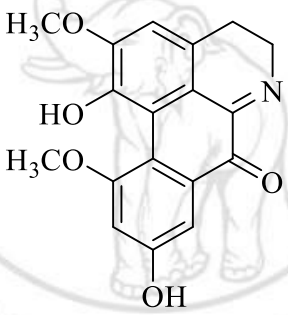
$R_1 = R_4 = R_6 = OCH_3$, $R_2 = R_3 = –OCH_2O–$, $R_5 = H$; Duguevalline (**u2**)

$R_1 = R_4 = R_5 = H$, $R_2 = R_3 = –OCH_2O–$, $R_6 = OCH_3$; Lanuginosine (**u3**)

$R_1 = R_4 = R_5 = R_6 = H$, $R_2 = R_3 = –OCH_2O–$; Liriodenine (**u4**)

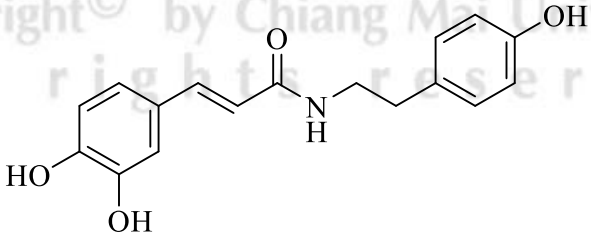
$R_1 = R_4 = R_5 = R_6 = H$, $R_2 = OH$, $R_3 = OCH_3$; 7-Oxodehydroasimilobine (**u5**)

$R_1 = R_5 = H$, $R_2 = R_3 = –OCH_2O–$, $R_4 = R_6 = OCH_3$; Oxodiscoguattine (**u6**)



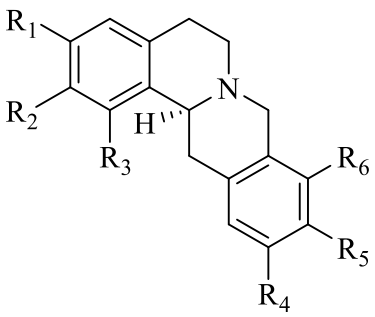
1,9-Dihydroxy-2,11-dimethoxy-4,5-dihydro-7-oxoaporphine (**u7**)

v) Phenylpropanoid Amide



trans-N-Caffeoyltyramine (**v1**)

w) Tetrahydroprotoberberine Alkaloids



$R_1 = R_6 = H$, $R_2 = R_4 = R_5 = OCH_3$, $R_3 = OH$; Caseadine (**w1**)

$R_1 = R_2 = OCH_3$, $R_3 = R_4 = H$, $R_5 = R_6 = –OCH_2O–$; Sinactine (**w2**)

$R_1 = R_2 = R_4 = R_5 = OCH_3$, $R_3 = R_6 = H$; Xylopinine (**w3**)

1.3 The Objectives of Research

The main research objective is to extract, isolate, purify and identify chemical constituents from *D. yunnanense* and *M. cuneata*. Crude extracts and pure compounds will be further evaluated for their antimalarial, antibacterial, anti-TB and cytotoxic activities.