

CHAPTER II

HISTORICAL

THE GENUS *STRYCHNOS*

The genus *Strychnos*, the largest genus of the family Loganiaceae, belongs to the tribes Strychneae, family Loganiaceae, order Gentianales. It was first described by Linnaeus on the basis of *Strychnos nux-vomica*, the type species, and *Strychnos colubrina* (*S. minor*). It is pantropical and comprises about 200 species, which may be subdivided into 3 geographically separated groups : one in Africa with 75 species² ; one in America with 73 species³ ; and one in Asia (including Australia) with 44 species⁴ . The only exception is *Strychnos potatorum* which is found both in Africa and Asia. The species are organized into 12 sections, arranged according to a more or less natural system.

Botanical Character

Usually lianas, sometimes shrubs or treelets ; usually provided with axillary, simple or double tendrils and sometimes with axillary thorns; stems and older branches in some species spiny. Stipules reduced to a mostly ciliate and straight rim connecting the leaf-bases. Leaves mostly inserted upon distinct leaf-cushions, 3-5(-7)-plinerved, i.e. apart from the midrib nearly always provided with one or a few pairs of nearly equally strongly developed basal nerves

which do not fully reach the leaf apex; penninerved in a few African species. Some pairs of scale-like cataphylls are present at the base of new shoots, of inflorescences, and of the branches of the latter. Inflorescences terminal or axillary, thyrsoïd. Bracts scale-like. Flower (4-)5-merous. Calyx nearly completely divided, lobes in Malasian spp. always broad, scale-like, and brown (in African and American spp. sometimes lanceolate and green), outside usually very sparsely hairy, ciliate along the margin, inside at the base provided with colleters. Corolla rotate to salver-shaped, white to yellowish or greenish, thin-fleshy, always more or less thickened towards the lobes, the basal part included by the calyx much thinner, outside usually distinctly densely papillose, mostly glabrous, inside variously hairy except the thin basal part; lobes valvate in bud, spreading to reflexed when open. Stamen exerted; anthers mostly slightly bifid at the base, intorse. Ovary 2-(in some African spp. 1-) celled, with many ovules; style cylindrical, stigma faintly 2-lobed. Berry usually globose or ellipsoid, the thin to thick shell in Malasian spp. always hard, outside smooth or minutely warty, glabrous, orange to red when ripe; pulp fleshy, usually orange. Seeds 2-1, either lenticular, orbicular to elliptic and usually convex on one and concave on the other side with a silky or felty testa, or irregular castorbean-shaped and glabrous; endosperm bony.

Distribution

About 150-200 species in the tropics and subtropics.

Ecology

Large lianas in the forests or scrambling or erect shrubs or treelets in more open vegetations.

Taxonomy

The genus *Strychnos* is organized into 12 sections, arranged according to botanical features².

	<u>Section</u>	<u>Total Number</u>	<u>Locality</u>	<u>Number of Species</u>
1.	Strychnos	46-48	Asia	10-12
			South America	36
2.	Rouhamon	20	Africa	11
			South America	9
3.	Breviflorae	32	Africa	12
			South America	20
4.	Penicillatae	15	Asia	5-6
			Africa	9
5.	Aculeatae	1	Africa	1
6.	Spinosae	4	Africa	4
7.	Brevitubae	14	Asia	7
			Africa	7
8.	Lanigerae	30	Asia	17
			Africa	12
9.	Phaeotrichae	1	Africa	1
10.	Densiflorae	8	Africa	8
11.	Dolichanthae	9	Africa	9
12.	Scyphostrychnos	1	Africa	1

The genus *Strychnos* is subdivided into 3 geographically separated groups which are Asian and Australian *Strychnos*, African *Strychnos*, and American *Strychnos*.

Asian and Australian *Strychnos*¹

Section *Strychnos*

1. *Strychnos angustiflora* Benth.
2. *S. cathayensis* Merr.
3. *S. cheliensis* Hu
4. *S. henryi* Merr. et Yamamoto ex Yamamoto
5. *S. ignatii* Berg.
6. *S. lucida* R.Br.
7. *S. narcondamensis* A.W.Hill
8. *S. nitida* G.Don
9. *S. nux-blanda* A.W.Hill
10. *S. nux-vomica* Linn.
11. *S. rupicola* Pierre ex Dop
12. *S. wallichiana* Steud. ex DC.

Section *Rouhamon*

13. *S. potatorum* L.f.

Section *Penicillatae*

14. *S. axillaris* Colebr.
15. *S. benthamii* C.B.Clarke
16. *S. dalzellii* C.B.Clarke
17. *S. melanocarpa* Gilg et Bened.
18. *S. ridleyi* King et Gamble
19. *S. trichocalyx* A.W.Hill

Section Brevitubae

20. *S. bicirrhosa* Lesch. et Wall.
 21. *S. flavescens* King et Gamble
 22. *S. luzonensis* Elmer
 23. *S. tetragona* A.W.Hill
 24. *S. umbellata* (Lour.) Merr.
 25. *S. vanprukii* Craib
 26. *S. vitiensis* A.W.Hill

Section Lanigeræ

27. *S. andamanensis* A.W.Hill
 28. *S. borneensis* Leenh.
 29. *S. coriacea* Thwaites
 30. *S. curtisii* King et Gamble
 31. *S. hypogyna* C.B.Clarke
 32. *S. lanata* A.W.Hill
 33. *S. ledermannii* Gilg et Bened.
 34. *S. maingayi* C.B.Clarke
 35. *S. minor* Dennst.
 36. *S. myrioneura* Gilg
 37. *S. oleifolia* A.W.Hill
 38. *S. ovata* A.W.Hill
 39. *S. polyantha* Pierre ex Dop
 40. *S. polytrichantha* Gilg
 41. *S. rufa* C.B.Clarke
 42. *S. thorelii* Pierre ex Dop
 43. *S. villosa* A.W.Hill

Not placed

44. *S. dinhensis* Pierre ex Dop

African *Strychnos*²

Section Rouhamon

1. *Strychnos boonei* De Wild.
2. *S. dale* De Wild.
3. *S. decussata* (Pappe) ex Gilg
4. *S. elaeocarpa* Gilg ex Leeuwenberg
5. *S. floribunda* Gilg
6. *S. gnetifolia* Gilg ex Onochie et Hepper
7. *S. ndengensis* Pellegr.
8. *S. potatorum* L.
9. *S. retinervis* Leeuwenberg
10. *S. usambarensis* Gilg
11. *S. variabilis* De Wild.

Section Breviflorae

12. *S. afzelii* Gilg
13. *S. angolensis* Gilg
14. *S. campicola* Gilg ex Leeuwenberg
15. *S. chromatoxylon* Leeuwenberg
16. *S. dolichothyrsa* Gilg ex Onochie et Hepper
17. *S. henningsii* Gilg
18. *S. icaja* Baill.
19. *S. malacoclados* C.H.Wright
20. *S. malchairii* De Wild.
21. *S. mimfiensis* Gilg ex Leeuwenberg
22. *S. mitis* S. Moore
23. *S. urceolata* Leeuwenberg

Section Penicillatae

24. *S. bifurcata* Leeuwenberg
25. *S. diplotricha* Leeuwenberg
26. *S. longicaudata* Gilg
27. *S. matopensis* S. Moore
28. *S. mostueoides* Leeuwenberg
29. *S. myrtoides* Gilg et Busse
30. *S. pentantha* Leeuwenberg
31. *S. tchibangensis* Pellegr.
32. *S. trichoneura* Leeuwenberg

Section Aculeatae

33. *S. aculeata* Solered.

Section Spinosa

34. *S. cocculoides* Bak.
35. *S. congolana* Gilg
36. *S. spinosa* Lam.
37. *S. ternata* Gilg ex Leeuwenberg

Section Brevitubae

38. *S. cuminodora* Leeuwenberg
39. *S. cuniculina* Leeuwenberg
40. *S. johnsonii* Hutch. et M.B.Moss
41. *S. mellodora* S.Moore
42. *S. millepunctata* Leeuwenberg
43. *S. samba* Duvign.
44. *S. xylophylla* Gilg

Section Lanigeræ

45. *S. chrysophylla* Gilg
46. *S. dinklagei* Gilg

47. *S. fallax* Leeuwenberg
48. *S. kasangaensis* De Wild.
49. *S. memecyloides* S.Moore
50. *S. moandoaensis* De Wild.
51. *S. ngouniensis* Pellegr.
52. *S. panganensis* Gilg
53. *S. scheffleri* Gilg
54. *S. soubrensis* Hutch. et Dalz.
55. *S. splendens* Gilg
56. *S. talbotiae* S.Moore

Section Phaeotrichae

57. *S. phaeotricha* Gilg

Section Densiflorae

58. *S. densiflora* Baill.
59. *S. innocua* Del.
60. *S. lucens* Bak.
61. *S. madagascariensis* Poir.
62. *S. nigritana* Bak.
63. *S. pungens* Solered.
64. *S. standtii* Gilg
65. *S. zenkeri* Gilg ex Bak.

Section Dolichanthae

66. *S. asterantha* Leeuwenberg
67. *S. barteri* Solered.
68. *S. canthioides* Leeuwenberg
69. *S. gossweileri* Exell
70. *S. melastomatoides* Gilg
71. *S. odorata* A.Chev.

72. *S. pernervis* A.Chev.
 73. *S. tricalysioides* Hutch. et M.B.Moss
 74. *S. xantha* Leeuwenberg

Section Scyphostrychnos

75. *S. camptoneura* Gilg et Busse

American Strychnos³

Section Strychnos

1. *Strychnos amazonica* Krukoff
 2. *S. araguaensis* Krukoff & Barneby
 3. *S. asperula* Sprague & Sandw.
 4. *S. bahiensis* Krukoff et Barneby
 5. *S. barnhartiana* Krukoff
 6. *S. brachiata* Ruiz & Pavon
 7. *S. bredemeyeri* (Schultes) Sprague & Sandw.
 8. *S. chlorantha* Prog.
 9. *S. colombiensis* Krukoff & Barneby
 10. *S. darienensis* Seem.
 11. *S. diaboli* Sandw.
 12. *S. divaricans* Ducke
 13. *S. erichsonii* Rich. Schomb.
 14. *S. eugeniifolia* Monachino
 15. *S. froesii* Ducke
 16. *S. gardneri* A.DC.
 17. *S. javariensis* Krukoff
 18. *S. jobertiana* Baill.
 19. *S. krukoffiana* Ducke
 20. *S. lobelioides* Krukoff & Barneby

21. *S. macrophylla* Barb.Rodr.
22. *S. medeola* Sagot ex Prog.
23. *S. mitscherlichii* Rich.Schomb.
24. *S. panamensis* Seem.
25. *S. peckii* B.L.Robinson
26. *S. pseudo-quina* A.St.Hil.
27. *S. pubiflora* Krukoff
28. *S. ramentifera* Ducke
29. *S. romeu-belenii* Krukoff & Barneby
30. *S. rondeletiioides* Spruce ex Benth.
31. *S. sandwithiana* Krukoff & Barneby
32. *S. solerederi* Gilg
33. *S. solimoesana* Krukoff
34. *S. tabascana* Sprague & Sandw.
35. *S. tomentosa* Benth.
36. *S. toxifera* Rob. Schomb.
37. *S. trinervis* (Vell.) Mart.
38. *S. xinguensis* Krukoff

Section Rouhamon

39. *S. bicolor* Prog.
40. *S. cogens* Benth.
41. *S. duckei* Krukoff & Monachino
42. *S. glabra* Sagot ex Prog.
43. *S. goiasensis* Krukoff & Barneby
44. *S. guianensis* (Aubl.) Mart.
45. *S. hirsuta* Spruce ex Benth.
46. *S. melinoniana* Baill.

47. *S. panurensis* Sprague & Sandw.

48. *S. subcordata* Spruce ex Benth.

Section Breviflorae

49. *S. acuta* Prog.

50. *S. atlantica* Krukoff & Barneby

51. *S. brachistantha* Standley

52. *S. brasiliensis* (Spreng.) Mart.

53. *S. castelnaeana* Wedd.

54. *S. cerradoensis* Krukoff & Barneby

55. *S. fendleri* Sprague & Sandw.

56. *S. fulvotomentosa* Gilg

57. *S. grayi* Grisebach

58. *S. malacosperma* Ducke & Froes

59. *S. mattogrossensis* S. Moore

60. *S. neglecta* Krukoff & Barneby

61. *S. nigricans* Prog.

62. *S. oiapocensis* Froes

63. *S. pachycarpa* Ducke

64. *S. parviflora* Spruce ex Benth.

65. *S. parvifolia* A. DC.

66. *S. poeppigii* Prog.

67. *S. progeliana* Krukoff & Barneby

68. *S. rubiginosa* A. DC.

69. *S. schultesiana* Krukoff

70. *S. tarapotensis* Sprague & Sandw.

***Strychnos* species in Thailand**

According to Bisset (1974)⁵ and Smitinand (1980)⁶, there are about 14 species of *Strychnos* in Thailand. These species are :

Section *Strychnos*

- ** 1. *Strychnos colubrina* Linn.
 (*S. silvicola* A.W.Hill)
 (*S. wallichiana* Steud. ex DC.)
เถากวางคูดุก Thao kwaang duu thuuk (Surat Thani);
เถาปลอง Thao plong (Ranong)
- *** 2. *S. ignatii* Berg
 (*S. krabiensis* A.W.Hill)
พญามือเหล็ก Phayaa mue lek (Krabi)
- *** 3. *S. lucida* R.Br.
 (*S. roborans* A.W.Hill)
พญามือเหล็ก Phayaa mue lek, **พญามูลเหล็ก** Phayaa muun lek (Central); **ยามือเหล็ก** Yaa mue lek (Krabi); **เสี้ยวคูก** Sieo duuk (Northern)
- *** 4. *S. nitida* G.Don
 (*S. kerrii* A.W.Hill)
सानดีลอก Saan dee lok (Chiang Mai)
- *** 5. *S. nux-blanda* A.W.Hill
กล้อวูแซ Klo-wuu-sae, **กล้ออี** Klo-ue, **กล๊ะอี** Kla-ue (Karen - Mae Hong Son) ; **ชีกา** Khee kaa (Northeastern); **ตุ้มกาขาว** Tuumkaakhaao (Central); **ปลูเวียด** Pluu-wiat (Khmer); **มะตัง** Mating, **มะตังตัน** Mating ton, **มะตังหมาก** Mating maak (Northern)

*** 6. *S. nux-vomica* Linn.

กระเจี๊ว Krachee , กระกิ้ง Ka kling , ตุมกาแดง
Tuumkaadaeng, แผลงใจ Salaeng chai (Central);
แผลงทม Salaeng thom , แผลงเบือ Salaeng buea
(Nakhon Ratchasima); แผลงเบือ Saeng buea (Ubon
Ratchathani); โสงบัวจี้ Hong-buai-chee (Chinese);
Snake wood

*** 7. *S. rupicola* Pierre ex Dop

(*S. usitata* Pierre ex Dop)

ชีกาเครือ Kheekaa khrua (Prachin Buri)

Section Penicillatae

*** 8. *S. axillaris* Colebr.

(*S. chloropetala* A.W.Hill)

(*S. kawbet* A.W.Hill)

(*S. mucronata* A.W.Hill)

(*S. plumosa* A.W.Hill)

(*S. schmidtii* Gilg)

(*S. viridiflora* A.W.Hill)

ชากไก่ Khwaak kai, นามเข็ม Naam khem (Chaiyaphum);

ขอเบ็ด Kho bet (Nong Khai); ชีแรด Khee raet

(Prachin Buri); เขี้ยว Khieo nguu (Chum-phon);

ตั้งเครือตำตัวแม่ Tueng khrua dam tua mae

(Lampang); เบน Ben, เบนขอ Ben kho (Northeastern);

เล็บครุฑ Lep khрут (Chanthaburi); เล็บรอก Lep rok

(Phatthalung); หมากตาไก่ Maak taa kai (Loei)

Section Brevitubae

*** 9. *S. vanprukii* Craib

เถาช้าง Thao chaang (Northern)

Section Lanigeræ

- * 10. *S. curtisii* King et Gamble
- *** 11. *S. minor* Dennst.
 (*S. beddomei* Clarke)
 (*S. silvicola* A.W.Hill)
 ตุมกาขาว Tum kaa khaao, **ตุมกาแดง** Tum kaa daeng
 (Lampang)
- * 12. *S. myrioneura* Gilg
- * 13. *S. polyantha* Pierre ex Dop
- *** 14. *S. thorelii* Pierre ex Dop
 เขียวขู Khieo nguu, ลุ่มนวก Lum nok (Chumphon); จองละอา
 Chong la aa, **ชองระอา** Chong ra aa (Chantaburi);
 เถาสะเอม Thao sa em , **สะเอ็ง** Sa eng (Trat)
- * reported by Bisset
- ** reported by Smitinand
- *** reported by Bisset and Smitinand

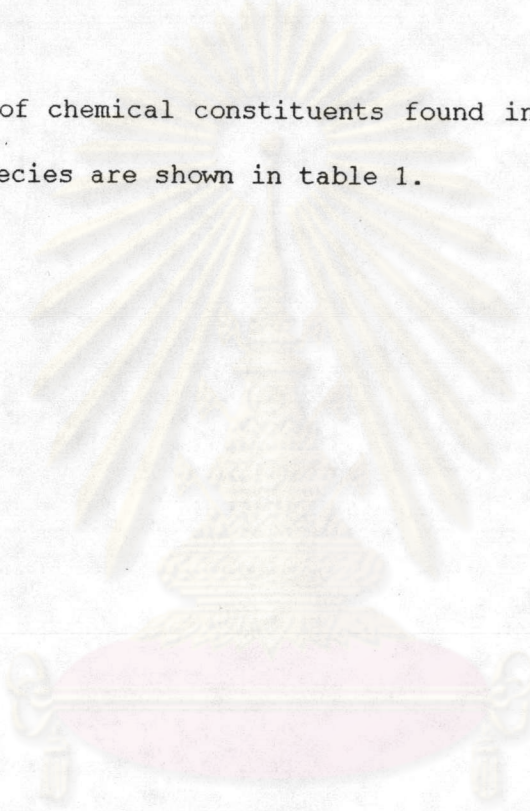
(The well-known vernacular name is in bold printed.)

จุฬาลงกรณ์มหาวิทยาลัย

Phytochemistry of the Genus *Strychnos*

The phytochemical studies on the *Strychnos* species indicated that the *Strychnos* species contain varieties of chemical constituents such as alkaloids, flavonoids, steroids, triterpenoids, benzenoids, lignans, lipids and miscellaneous compounds.

Lists of chemical constituents found in various species of the *Strychnos* species are shown in table 1.



ศูนย์วิจัยทรัพยากร
จุฬาลงกรณ์มหาวิทยาลัย

Table 1 Chemical Constituents of the *Strychnos* species

Botanical origin	Plant part	Chemical Substances	Category	Reference
<i>S. aculeata</i>	sb	spermostrychnine	IA	7
	sb	isosplendine	IA	7
	rb	strychnofendlerine	IA	8
	rb	deacetylstrychnofendlerine	IA	8
	sb	<i>N</i> -(1)-acetyl- <i>O</i> -methyl- strychnosplendine	IA	7
	sb	<i>N</i> -(1)-acetylstrychnosplendine	IA	7
	rb	<i>N</i> -(1)-acetyl- <i>O</i> -methyl- strychnosplendine	IA	8
	sb	<i>N</i> -acetylstrychnosplendine	IA	9
	<i>S. afzelii</i>	sb	campesterol	ST
sb		diaboline	IA	10
sb		β -sitosterol	ST	10
sb		stigmasterol	ST	10
sb		bis-nor-dihydrotoxiferine <i>N</i> -oxide	IA	10
<i>S. alvimiana</i>	b	alvimine	IA	11
	b	alviminine	IA	11
	b	strychnobrasiline	IA	11
	b	strychnosiline	IA	11
	b	tabascanine	IA	11
	b	acetyltabascanine	IA	11
<i>S. angolensis</i>	rt, sb	11-methoxymacusine	IA	12
<i>S. barteri</i>	rt, sb	akagerine	IA	13
	s	nigritanine	IA	13
	sb	18-dehydronigritanine	IA	13

Botanical origin	Plant part	Chemical substances	Category	Reference
<i>S. brachiata</i>	rb, sb	11-methoxydiaboline	IA	14
	sb	deacetyldiaboline	IA	14
	rb, sb	macusine B	IA	14
<i>S. camptoneura</i>	sb	akagerine	IA	15
	sb	angustine	IA	15
	sb	antirhine	IA	15
	sb	antirhine methosalt	IA	15
	sb	camptoneurine	IA	15
	sb	retuline	IA	15
	sb	retuline- <i>N</i> -oxide	IA	15
	sb	retuline- <i>N</i> -oxide	IA	15
<i>S. castelnaeana</i>	tb	diaboline	IA	16
	tb	3-hydroxydiaboline	IA	16
<i>S. cathayensis</i>	s	diaboline	IA	17
	s	11-methoxydiaboline	IA	17
	s	henningsoline	IA	17
<i>S. chrysophylla</i>	sb	longicaudatine	IA	18
<i>S. colubrina</i>	ep	β -sitosterol	ST	19
<i>S. confertiflora</i>	s	strychnine	IA	20
<i>S. dale</i>	sb	17- <i>O</i> -methylakagerine	IA	21
	sb	akagerine	IA	21
	sb	3,14-dihydrodecussine	IA	22
	sb	decussine	IA	22
	sb	kribine	IA	21
	sb	21- <i>O</i> -methylkribine	IA	21
	sb	21- <i>O</i> -methylepikribine	IA	21

Botanical origin	Plant part	Chemical substances	Category	Reference
<i>S. decussata</i>	l	3(S),17(S)-tetrahydro-10,10'- dimethoxy-N-4'-methyl, cis- usambarensine	IA	23
	l	3(S),17(S)-tetrahydro-10,10'- dimethoxy-cis-usambarensine	IA	23
	sb	akagerine	IA	24
	sb	akagerine lactone	IA	25
	sb	10-hydroxy-17-O-methylakagerine	IA	24
	sb	10-hydroxyakagerine	IA	25
	sb	17-O-methylakagerine	IA	24
	sb	decussine	IA	26
	sb	3,14-dihydro,10-hydroxydecussine	IA	22
	sb	10-hydroxy-21-O-methylkribine	IA	24
	sb	10-hydroxy-21-O-methylepikribine	IA	24
	sb,rb	macusine B	IA	27
	sb,rb	O-methylmacusine B	IA	27
	sb,rb	malindine	IA	27
	sb	(+)mostueine	IA	22
<i>S. dinklagei</i>	l	16,17-dihydro,22-deoxystricto- samide	IA	28
	sb	bis-nor-dihydrotoxiferine	IA	22
	b	brafouedine	IA	29
	b	isobrafouedine	IA	29
	l	cantleyine	MA	30
	l	dinklageine	MA	30
	sb	ellipticine	IA	31

Botanical origin	Plant part	Chemical substances	Category	Reference
	sb	10-hydroxyellipticine	IA	31
	sb	17-oxoellipticine	IA	31
	sb	17-oxoellipticine- M_b -oxide	IA	31
	sb	18-hydroxyellipticine	IA	31
	sb	3,14,4,21-tetrahydroellipticine	IA	31
	sb	3,14-dihydroellipticine	IA	31
	b	dihydroellipticine	IA	32
	sb	ellipticine- M_b -oxide	IA	31
	sb	gentianine	MA	31
	sb	lirioresinol A	LN	31
	sb	lirioresinol B	LN	31
	l	3,4-dehydro,1-oxo-	MT	30
		loganin aglycone		
	sb	strellidimine	IA	33
	l	strychnovoline	MA	30
	sb	syringic acid methyl ester	BZ	31
	sb	vernoterpene	AK	31
<i>S. divaricans</i>	rt	divaricine	IA	34
	rt	vellosimine	IA	34
<i>S. dolichothyrsa</i>	l	bis-nor-C-alkaloid H	IA	35
	sb	campesterol	ST	36
	l, sb	caracurine V	IA	35
	sb	caracurine V-di-N-oxide	IA	37
	sb	caracurine V-N-oxide	IA	37
	sb	C-fluoro:bis-nor-curarine	IA	38
	sb	filican-3-one	TT	39

Botanical origin	Plant part	Chemical substances	Category	Reference
<i>S. elaeocarpa</i>	sb	paracurine V	IA	37
	sb	β -sitosterol	ST	36
	sb	stigmasterol	ST	36
	sb	bis-nor-dihydrotoxiferine	IA	38
	sb	bis-nor-dihydrotoxiferine-di- N-oxide	IA	38
	sb	bis-nor-dihydrotoxiferine-N-oxide	IA	38
	sb	akagerine	IA	21
	sb	17-O-methylakagerine	IA	21
	ns	O-methylakagerine	IA	40
	sb	decussine	IA	22
	sb	kribine	IA	21
	sb	21-O-methylkribine	IA	21
	sb	21-O-methylepikribine	IA	21
	sb	(+)-mostueine	IA	22
	sb	strychnocarpine	IA	41
	<i>S. erichsonii</i>	sb	bis-nor-dihydrotoxiferine	IA
sb		16-epiaffinine	IA	42
sb		16-epi-O-acetylaaffinine	IA	42
<i>S. fendleri</i>	sb	erichsonine	IA	42
	sb	diaboline	IA	43
	sb	henningsamine	IA	43
	sb	spermostrychnine	IA	43
	sb	11-methoxystrychnofendlerine	IA	43
	sb	strychnofendlerine	IA	43

Botanical origin	Plant part	Chemical substances	Category	Reference
<i>S. floribunda</i>	sb	12-hydroxy-11-methoxy- strychnofendlerine	IA	43
	sb	<i>N</i> - (A)-acetylstrychnosplendine	IA	43
	sb	<i>N</i> - (A)-acetyl-12-hydroxy- 11-methoxystrychnosplendine	IA	43
	sb	akagerine	IA	44
	sb	campesterol	ST	44
	sb	decussine	IA	44
	sb	deacetylisoretuline	IA	44
	sb	isorosibiline	IA	44
	sb	rouhamine	IA	44
	sb	β -sitosterol	ST	44
	sb	stigmasterol	ST	44
	sb	strychnocarpine	IA	44
<i>S. gardneri</i>	sb	bis-nor-dihydrotoxiferine	IA	44
	rb	akagerine	IA	45
<i>S. gaultheriana</i>	rb	11-methoxydiaboline	IA	45
	s, sb	brucine	IA	46
	s, sb	α -colubrine	IA	46
<i>S. gossweileri</i>	s, sb	strychnine	IA	46
	rb	alstonine	IA	47
	rb	diploceline	IA	47
	rb	dolichantoside	IA	47
	rb	matadine	IA	48
	rb	strychnochromine	IA	47
	rb	strychnofluorine	IA	49

Botanical origin	Plant part	Chemical substances	Category	Reference
	rb	strychnoxanthine	IA	47
<i>S. hainanensis</i>	s	brucine	IA	20
	s	strychnine	IA	20
<i>S. henningsii</i>	l	cyclostrychnine	IA	50
	sb	friedelin	TT	51
	l	henningsamide	IA	50
	l	dehydroacetylhenningsamide	IA	50
	l	O-acetylhenningsamide	IA	50
	l	henningsiine	IA	50
	l	3-hydroxyhenningsiine	IA	50
	l	dehydroxyacetylhenningsiine	IA	50
	l	O-acetylhenningsiine	IA	50
	l	henningsiine-N(4)-oxide	IA	50
	sb, rb	holstiine	IA	50
	sb, l	holstiline	IA	51
	sb, rb	retuline	IA	50
	l, st	18-hydroxyisoretuline	IA	52
	l, st	N- (A)-deacetyl isoretuline	IA	52
	l, st	N- (A)-deacetyl, 18-hydroxy-17-O-acetyl- isoretuline	IA	52
	l, st	N- (A)-deacetyl, 18-hydroxy-isoretuline	IA	52
	sb, l	O-acetylretuline	IA	51
	l	spermostrychnine	IA	50
	l	17,23-dihydroxyspermostrychnine	IA	50
	sb	19-epi, 23-hydroxyspermostrychnine	IA	50

Botanical origin	Plant part	Chemical substances	Category	Reference
	l, rb, sb	23-hydroxyspermostrychnine	IA	50
	l	23-hydroxyspermostrychnine- N(4)-oxide	IA	50
	l, rb, sb	splendoline	IA	50
	rb	N(A)-acetyl-11-methoxy - strychnosplendine	IA	53
	rb	N(A)-acetylstrychnosplendine	IA	53
	l, st	tsilanimbine	IA	52
	l, st	tsilanine	IA	52
	l, st	10-methoxytsilanine	IA	52
	l, st	O-demethyltsilanine	IA	52
	l, st	O-demethyl, 10-methoxytsilanine	IA	52
<i>S. hirsuta</i>	rb, sb	strychnohirsutine	IA	54
	rb, sb	tetradehydrostrychnohirsutine	IA	54
<i>S. icaja</i>	l	icajine	IA	55
	l	novacine	IA	55
	rb	12, 20- α -epoxy-15-hydroxynovacine	IA	56
	rb	19, 20- α -epoxynovacine	IA	56
	l	21, 22- α -epoxynovacine	IA	55
	rb	strychnine	IA	56
	l, fr	14-hydroxy-2,3-dimethoxy, 21, 22- α - epoxy-N-methyl-sec-pseudostrychnine	IA	55
	fr	14-hydroxy-4-methoxy-21, 22- α -epoxy- N-methyl-sec-pseudostrychnine	IA	55
	l, fr	2-3-dimethoxy-21, 22- α - epoxy-N- methyl-sec-pseudostrychnine	IA	55

Botanical origin	Plant part	Chemical substances	Category	Reference
<i>S. ignatii</i>	l	3,4-dimethoxy-21,22- α - epoxy- <i>N</i> -methyl- <i>sec</i> -pseudostrychnine	IA	55
	l	3-methoxy- <i>N</i> -methyl- <i>sec</i> -pseudostrychnine	IA	55
	fr	4,14-dihydroxy-2,1,22- α -epoxy- <i>N</i> -methyl- <i>sec</i> -pseudostrychnine	IA	55
	l	4,14-dihydroxy-3-methoxy-21,22- α -epoxy- <i>N</i> -methyl- <i>sec</i> -pseudostrychnine	IA	55
	l, fr	4-hydroxy,3-methoxy-21,22- α -epoxy- <i>N</i> -methyl- <i>sec</i> -pseudostrychnine	IA	55
	fr	4-methoxy-21,22- α -epoxy- <i>N</i> -methyl- <i>sec</i> -pseudostrychnine	IA	55
	rb	<i>N</i> -methylstrychninium	IA	56
	rb	sungucine	IA	56
	rb	bis-nor-dihydrotoxiferine	IA	56
	l, fr	vomicine	IA	55
	l	21,22- α -epoxyvomicine	IA	55
	s	brucine	IA	57
	rw, sw	macusine B	IA	58
	rw, sw	<i>O</i> -methylmacusine B	IA	58
	rw, sw	nor-melinonine B	IA	58
	rw, sw, s	strychnine	IA	58
	rw, sw	10-hydroxystrychnine	IA	58
rw, sw	isostrychnine	IA	58	
rw, sw	protostrychnine	IA	58	
rw, sw	pseudostrychnine	IA	58	

Botanical origin	Plant part	Chemical substances	Category	Reference
	rw,sw	strychnine- <i>N</i> -oxide	IA	58
<i>S. jobertiana</i>	rb	akagerine	IA	45
	rb	diaboline	IA	45
<i>S. johnsonii</i>	rb, sb	ajmalicinial	IA	59
	rb	akagerine	IA	59
	rb, sb	akagerine lactone	IA	59
	rb	<i>O</i> -ethylakagerine lactone	IA	59
	rb	<i>O</i> -ethylakagerine	IA	59
	rb, sb	tetrahydroakagerine	IA	59
	rb, sb	tetrahydroalstonial	IA	59
	rb	angustine	IA	59
	sb	anthirine lactone	IA	59
	sb	isoanthirine	IA	59
	sb	dihydrocorynantheol	IA	59
	rb, sb	dihydrocycloakagerine	IA	59
	rb	dihydrodecussine	IA	59
	rb, sb	demethoxycarbonyl-3,14-dihydro- gambirtanine	IA	59
	rb	harman	IA	59
	rb	nor-harman	IA	59
	rb, sb	janussine A	IA	59
	rb, sb	janussine B	IA	59
	rb	nor-malindine	IA	59
	rb	nor-epimalindine	IA	59
	sb	anthirine	IA	59
	sb	yohimb-19-ene	IA	59

<i>Botanical origin</i>	<i>Plant part</i>	<i>Chemical substances</i>	<i>Category</i>	<i>Reference</i>
<i>S. kasengaensis</i>	sb, rb	matopensine	IA	60
	sb	monomatopensine- <i>N</i> -oxide	IA	60
	rb	isoretulinal	IA	60
	rb, sb	retuline	IA	60
	sb	11- <i>O</i> -methylretuline	IA	60
	rb	deacetylretuline	IA	60
	sb	isoretuline	IA	60
	sb	11- <i>O</i> -methylisoretuline	IA	60
	rb	deacetylisoretuline	IA	60
	sb	<i>N</i> (1)-deacetyl, 18-acetoxyretuline	IA	60
	sb	<i>O</i> -acetylretuline	IA	60
	sb	isositsirikine	IA	60
	rb	16,17-dehydroisostrychnobiline	IA	60
	sb	bis-nor-dihydrotoxiferine	IA	61
	sb	nor-dihydrotoxiferine	IA	60
<i>S. ligustrina</i>	sb	wieland-Gumlich aldehyde	IA	60
	sb	wieland-Gumlich diol	IA	60
<i>S. ligustrina</i>	sb	brucine	IA	46
	sb	α -colubrine	IA	46
<i>S. longicaudata</i>	rb	bis-nor-C-alkaloid H	IA	62
	s	cantleyine	MA	63
	s	tetrahydrocantleyine	MA	63
	sb	diaboline	IA	62
	sb	flavopeirerine	IA	62
	sb, rb	longicaudatine	IA	62
	sb, rb	longicaudatine F	IA	62

Botanical origin	Plant part	Chemical substances	Category	Reference
<i>S. lucida</i>	sb,rb	longicaudatine Y	IA	62
	rb	nor-mavacurine	IA	64
	sb	1,2-dehydro-deacetylretuline	IA	62
	sb	23-hydroxy-2,16-dehydroretuline	IA	62
	sb	N(1)-deacetyl-18-acetoxyretuline	IA	62
	sb	N(1)-deacetyl-18-hydroxyretuline	IA	62
	s	strychnolvoline	MA	63
	rb, sb	nor-dihydrotoxiferine	IA	62
	rb, sb	wieland-Gumlich aldehyde	IA	62
	tw	brucine	IA	65
	tw	pseudobrucine	IA	65
	tw	brucine-N-oxide	IA	65
	tw	β -colubrine	IA	65
	tw	β -colubrine-N-oxide	IA	65
	tw	β -pseudocolubrine	IA	65
	tw	gentianine	MA	65
	w	ligustrinoside	MT	66
	w	loganetin	MT	66
	w	loganic acid	MT	66
	w	loganin	MT	66
<i>S. matopensis</i>	tw	strychnine	IA	65
	tw	pseudostrychnine	IA	65
	tw	strychnine-N-oxide	IA	65
	rb	bis-nor-C-alkaloid D	IA	67
	rb	bis-nor-C-alkaloid H	IA	67
	rb	bis-nor-curarine C	IA	67

Botanical origin	Plant part	Chemical substances	Category	Reference
	rb	diaboline	IA	67
	rb	11-methoxydiaboline	IA	67
	rb	nor-fluorocurarine C	IA	67
	rb	longicaudatine	IA	67
	rb	longicaudatine F	IA	67
	rb	longicaudatine Y	IA	67
	rb	longicaudatine Z	IA	67
	rb	<i>N</i> -oxy-longicaudatine	IA	67
	sb, rb	matopensine	IA	67
	rb	18,18'-bis-hydroxymatopensine	IA	67
	rb	18-hydroxymatopensine	IA	67
	rb	16-ethoxyisomatopensine	IA	67
	rb	16-methoxyisomatopensine	IA	67
	rb	matopensine- <i>N</i> -oxide	IA	67
	rb	<i>N</i> -deacetylisoetuline	IA	67
	rb	<i>N</i> -deacetylretuline	IA	67
	rb	isorosibiline	IA	67
	rb	isositsirikine	IA	67
	rb	strychnofuranine	IA	67
	rb	bis-nor-dihydrotoxiferine	IA	67
	rb	wieland-Gumlich aldehyde	IA	67
	rb	desoxywieland-Gumlich aldehyde	IA	67
	rb	<i>N</i> -formyl-1,8-desoxy-wieland-Gumlich aldehyde	IA	67
<i>S. mattogrossensis</i> br		mattogrossine	IA	68

Botanical origin	Plant part	Chemical substances	Category	Reference
	br	12-hydroxy,11-methoxystrychno- brasiline	IA	68
	br	strychnobrasiline	IA	68
<i>S. melinoniana</i>	b	melinonine A	IA	69
	b	melinonine E	IA	69
<i>S. mimfiensis</i>	rb	nor-mavacurine	IA	64
	rb	mimfiensine	IA	64
<i>S. mostueoides</i>	rb	nor-macusine B	IA	70
	rb	malagashanine	IA	70
	rb	malagashine	IA	70
	rb	spermostrychnine	IA	70
	rb	strychnobrasiline	IA	70
	rb	deacetylstrychnobrasiline	IA	70
	rb	strychnofendlerine	IA	70
	rb	wieland-Gumlich aldehyde	IA	70
<i>S. ngouniensis</i>	sb	nor-fluorocurarine	IA	62
	sb	18-acetoxy-nor-fluorocurarine	IA	62
	rt, st	(dl)-16-hydroxy-alloibogamine	IA	71
	sb, rb	longicaudatine	IA	62
	sb, rb	ngouniensine	IA	62
	sb, rb	epingouniensine	IA	62
	rb	epi-glucosylngouniensine	IA	62
	rb	glucosylngouniensine	IA	62
	sb	10'-hydroxy-4',17- α -dihydro- tchibangensine	IA	62
	sb	17- α ,4',17-dihydro-tchibangensine	IA	62

Botanical origin	Plant part	Chemical substances	Category	Reference
	rb	17- α ,4',17-dihydro,10'-hydroxy-tchibangensine	IA	62
	sb	17- β ,4',17-dihydro,10'-hydroxy-tchibangensine	IA	62
	rb	17- β ,4',17-dihydro-tchibangensine	IA	62
	rb	17- β ,4',17-dihydro,10'-hydroxy-tchibangensine	IA	62
	sb,rb	tubotaiwinal	IA	62
<i>S. nigritana</i>	s, sb	nigritanine	IA	13
	sb	18-dehydronigritanine	IA	13
<i>S. nux-vomica</i>	s	brucine	IA	72
	s	isobrucine	IA	72
	s	isobrucine-N-oxide	IA	72
	s	pseudobrucine	IA	73
	s	brucine-N-oxide	IA	72
	peri, fr	cantleyine	MA	74
	s	α -colubrine	IA	73
	s	β -colubrine	IA	73
	peri	β -N-methyl-sec-pseudocolubrine	IA	74
	fr	cuchiloside	BZ	75
	s	icajine	IA	72
	fr	loganin	MT	74
	fr	deoxyloganin	MT	74
	fr	ketologanin	MT	74
	fr	secologanin	MT	74
	rb	16-epi-O-methyl-macusine B	IA	76

Botanical origin	Plant part	Chemical substances	Category	Reference
	rb, l	nor-macusine B	IA	76
	rb	O-methylmacusine B	IA	76
	rb	nor-melinonine B	IA	76
	s	novacine	IA	72
	rb	protostrychnine	IA	76
	fr	salidroside	BZ	75
	s	strychine	IA	77
	s	strychnine	IA	73
	rb, l	isostrychnine I	IA	76
	l	19,20-dihydroisostrychnine I	IA	76
	rb	10-hydroxystrychnine	IA	76
	rt, tw, l, tb	12-hydroxy, 11-methoxystrychnine	IA	76
	rt, tw, l, tb	12-hydroxystrychnine	IA	76
	s	2-hydroxy, 3-methoxystrychnine	IA	72
	l	3, 12-dihydroxy, 11-methoxy- strychnine	IA	76
	l	3, 12-dihydroxystrychnine	IA	76
	l, tb	3-hydroxy-10, 11-dimethoxy- strychnine	IA	76
	l	3-hydroxystrychnine	IA	76
	rb	4-hydroxy-3-methoxystrychnine	IA	78
	rb	4-hydroxystrychnine	IA	78
	rb	isostrychnine	IA	78
	s	isostrychnine-N-oxide	IA	72
	rb	protostrychnine	IA	78
	s	pseudostrychnine	IA	72

Botanical origin	Plant part	Chemical substances	Category	Reference
	l	strychnine- <i>N</i> -(<i>B</i>)-oxide	IA	76
	l	10,11-dimethoxystrychnine- <i>N</i> -(<i>B</i>)-oxide	IA	76
	l	12-hydroxy-11-methoxy-strychnine- <i>N</i> -(<i>B</i>)-oxide	IA	76
	l	12-hydroxystrychnine- <i>N</i> -(<i>B</i>)-oxide	IA	76
	s	strychnine- <i>N</i> -oxide	IA	72
	s	vomicine	IA	72
<i>S. parvifolia</i>	rb	akagerine	IA	45
<i>S. pierreana</i>	ep	strychnine	IA	79
<i>S. potatorum</i>	rb	akuamidine	IA	80
	s	amyrin-lupeol	TT	81
	rb	antirhine	IA	80
	rb	18,19-dihydro, 10(<i>R</i>) antirhine	IA	80
	rb	18,19-dihydro, 20(<i>S</i>) antirhine	IA	80
	s	arachidic acid	LP	82
	l,b	campesterol	ST	83
	rb	cantleyine	MA	80
	rb	diaboline	IA	80
	rb	11-methoxydiaboline	IA	80
	rb	12-hydroxy-11-methoxy- diaboline	IA	80
	rb	diaboline- <i>N</i> -oxide	IA	80
	rb	nor- <i>C</i> -fluorocurarine	IA	80
	s	D-galactose	CB	84
	s	gum	CB	85
	rb	harman carboxide	IA	80

Botanical origin	Plant part	Chemical substances	Category	Reference
	rb	nor-harman	IA	80
	rb	henningsamine	IA	80
	rb	11-methoxyhenningsamine	IA	80
	s	lignoceric acid	LP	82
	s	linoleic acid	LP	82
	rb	dihydrolongicaudatine Y	IA	80
	rb	dihydrolongicaudatine	IA	80
	rb	nor-macusine B	IA	80
	s	D-mannose	CB	84
	rb	nor-mavacurine	IA	80
	l	isomotirol	TT	83
	rb	ochrolifuanine A	IA	80
	rb	ochrolifuanine E	IA	80
	s	oleanolic acid	TT	84
	s	oleanolic acid-3-O- β -acetate	TT	84
	s	oleic acid	LP	82
	s	palmitic acid	LP	82
	rb	polyneuridine	IA	80
	rb	deacetylretuline	IA	80
	s	β -sitosterol	ST	84
	s	stearic acid	LP	82
	s	stigmasterol	ST	81
	s	strychnos mannogalactan	CB	86
	rb	bis-nor-dihydrotoxiferine	IA	80
	rb	18,19-dihydrousambarensine	IA	80
<i>S. pseudo-quina</i>	b	cinchonidine	QA	87

Botanical origin	Plant part	Chemical substances	Category	Reference
	b	cupreine	QA	87
	l	diaboline	IA	88
	l	11-methoxydiaboline	IA	88
	b	quinidine	QA	87
	b	quinine	QA	87
	l	isorhamnetin	FN	88
	l	strychnobiflavone	FN	88
<i>S. pungens</i>	l, sb, rb	diaboline	IA	89
	l, sb, rb	11-methoxy-neo-oxydiaboline	IA	89
	l, sb, rb	11-methoxydiaboline	IA	89
	l, sb, rb	12-hydroxy-11-methoxy diaboline	IA	89
	l, sb, rb	henningsamine	IA	89
	l, sb, rb	11-methoxyhenningsamine	IA	89
	l, sb, rb	12-hydroxy-11-methoxy henningsamine	IA	89
	l, sb, rb	O-acetylretuline	IA	89
	l, sb, rb	sitsirikine	IA	89
	l, sb, rb	16(R)-isositsirikine	IA	89
	l, sb, rb	16(S)-isositsirikine	IA	89
<i>S. roborans</i>	fr	7-keto-loganin	MT	90
<i>S. rubiginosa</i>	rb, sb	11-methoxydiaboline	IA	91
	rb, sb	nor-macusine B	IA	91
	rb	strychnorubigine	IA	91
<i>S. scheffleri</i>	sb	flurocurine C	IA	92
	sb	mavacurine C	IA	92
	sb	deacetylisoetuline	IA	92
	l	strychnobrasiline	IA	92

Botanical origin	Plant part	Chemical substances	Category	Reference
	l	strychnofendlerine	IA	92
	l	<i>N</i> -(A)-acetylstrychnosplendine	IA	92
	l	<i>N</i> -(A)-acetyl- <i>O</i> -methylstrychnosplendine	IA	92
	sb	bis-nor-dihydrotoxiferine	IA	92
<i>S. solimoesana</i>	ns	calebassinine 1	QA	93
<i>S. soubrensis</i>	sb	isosplendine	IA	94
	sb	strychnobrasiline	IA	94
	sb	14- β -hydroxystrychnobrasiline	IA	94
	sb	strychnofendlerine	IA	94
<i>S. spinosa</i>	l, sb	akagerine	IA	95
	l	10-hydroxyakagerine	IA	95
	sb	11-methoxydiaboline	IA	96
	sb	12-hydroxy-11-methoxydiaboline	IA	96
	fr	kingiside aglucone	MT	97
	l	kribine	IA	95
<i>S. staudtii</i>	rt, sb, l	11-methoxydiaboline	IA	98
	rt, sb, l	12-hydroxy-11-methoxy diaboline	IA	98
	rt, sb, l	11-methoxyhenningsamine	IA	98
	rt, sb, l	12-hydroxy-11-methoxyhenningsamine	IA	98
<i>S. tchibangensis</i>	l, rt, tb	tchibangensine	IA	99
<i>s. toxifera</i>	sb	macusine B	IA	100
	sb	panarine	IA	100
<i>S. tricalysioides</i>	sb	dolichantoside	IA	101
	s	vallesiachotamine	IA	102
	s	isovallesiachotamine	IA	102

Botanical origin	Plant part	Chemical substances	Category	Reference
<i>S. trinervis</i>	rt	longicaudatine	IA	103
	rt	nor-macusine B	IA	103
	rt	bis-nor-dihydrotoxiferine	IA	103
	rt	bis-nor-dihydrotoxiferone	IA	103
	rt	trinervine	IA	103
<i>S. urceolata</i>	sb	bis-nor-C-alkaloid H	IA	35
	sb	caracurine V	IA	10
	sb	bis-nor-dihydrotoxiferine	IA	10
<i>S. usambarensis</i>	rt	afrocurarine	IA	104
	rt	akagerine	IA	105
	rb	<i>N</i> _b -methylantirrhine	IA	106
	rb	calebassine	IA	107
	sb	10-hydroxy- <i>N</i> -methylcorynantheol	IA	108
	sb	<i>N</i> (_b)-methyl,10-hydroxycorynantheol	IA	109
	rb	curarine I,C	IA	107
	st	fluorocurarine	IA	109
	rb	5,6-dihydroflavopereirine	IA	110
	rt	6,7-dihydroflavopereirine	IA	111
	ep	dihydroflavopereirine	IA	112
	fr	dihydro-de-(carbomethoxy)- gambirtannine	IA	113
	sb	harman	IA	109
	b	macusine B	IA	114
b	dihydro- <i>O</i> -methylmacusine B	IA	114	
b	<i>O</i> -methylmacusine B	IA	114	
rb	malindine	IA	106	

Botanical origin	Plant part	Chemical substances	Category	Reference
	rb	isomalindine	IA	106
	rb	melinonine F	IA	110
	rb	nor-melinonine F	IA	110
	l	moenjodaramine	TA	115
	sb	strychnofoline	IA	109
	sb	isostrychnofoline	IA	109
	sb	strychnopentamine	IA	109
	l	isostrychnopentamine	IA	116
	l	isostrychnophylline	IA	117
	l	strychnophylline	IA	117
	rb	C-dihydrotoxiferine	IA	107
	rt	usambarensine	IA	111
	rt	3,4-dihydrousambarensine	IA	111
	rt	3,4-dihydro-N'-(B)-methyl- usambarensine	IA	111
	rb	3,4-dihydro-N-(B)-methyl- usambarensine	IA	118
	sb	dihydrousambarensine	IA	109
	rt	N'-(B)-methylusambarensine	IA	111
	rb	N-(B)-methylusambarensine	IA	118
	sb	usambarine	IA	109
	l	10-hydroxy-N-(B)-methylusambarine	IA	115
	sb	10-hydroxyusambarine	IA	109
	l	11-hydroxy-N-(B)-methylusambarine	IA	115
	sb	11-hydroxyusambarine	IA	109
	l	18,19-dihydrousambarine	IA	119

Botanical origin	Plant part	Chemical substances	Category	Reference
<i>S. variabilis</i>	sb	dihydrousambarine	IA	109
	sb	<i>N</i> -(B)-methyl,10-hydroxyusambarine	IA	109
	rb	2- β ,16- α -dihydro- <i>N</i> -acetyl (+) akuammicinol	IA	120
	rb	2- β ,16- β -dihydro(-) akuammicinol	IA	120
	s	cantleyine	MA	63
	s	tetrahydrocantleyine	MA	63
	rb	18-deoxydiaboline	IA	121
	rb	C-fluorocurine	IA	122
	l	hyperoside	FN	123
	l	kaempferol-3-(4"-cis- <i>p</i> -coumaroyl)- robinobioside	FN	124
	l	kaempferol-3-(4"-trans- <i>p</i> -coumaroyl)- robinobioside	FN	124
	l	kaempferol-3-robinobioside	FN	124
	l	kaempferol-3-robinobioside- 7-glucoside	FN	124
	l	kaempferol-3- <i>O</i> -robinobioside	FN	123
	rb	C-mavacurine	IA	122
	l	quercetin-3-(4"-cis- <i>p</i> -coumaroyl)- robinobioside	FN	124
	l	quercetin-3-(4"-trans- <i>p</i> -coumaroyl)- robinobioside	FN	124
	l	quercetin-3-robinobioside	FN	124
	l	quercetin-3-robinobioside- 7-glucoside	FN	124

Botanical origin	Plant part	Chemical substances	Category	Reference
	l	quercetin-3- <i>O</i> -robinobioside	FN	123
	l	quercetin-3-rhamnosyl-(1,6)- galactoside-7-glucoside	FN	125
	rb	retulinal	IA	126
	rb	12-hydroxyisoretulinal	IA	126
	rb	12-hydroxyretulinal	IA	126
	rb	isoretulinal	IA	126
	rb	16-hydroxyisoretulinal	IA	127
	rb	retuline	IA	121
	rb	isoretuline	IA	121
	rb	deacetylretuline	IA	121
	s	11-methoxy- <i>O</i> -acetylisoretuline	IA	63
	s	11-methoxyisoretuline	IA	63
	s	<i>O</i> -acetylisoretuline	IA	63
	rb	deacetylisoretuline	IA	121
	rb	rosibiline	IA	127
	rb	strychnobiline	IA	121
	rb	12'-hydroxystrychnobiline	IA	128
	rb	isostrychnobiline	IA	121
	rb	12'-hydroxyisostrychnobiline	IA	121
	rb	16,17-didehydroisostrychnobiline	IA	129
	rb	strychnopivotine	IA	127
	s	strychnovoline	MA	63
	rb	strychnozairine	IA	130
	rb	nor-dihydrotoxiferine	IA	121
	l	variabiloside A	FN	124

Botanical origin	Plant part	Chemical substances	Category	Reference
<i>S. wallichiana</i>	l	variabiloside B	FN	124
	l	variabiloside C	FN	124
	l	variabiloside D	FN	124
	l	variabiloside E	FN	125
	l	variabiloside F	FN	125
	l	variabiloside G	FN	125
	l	variabiloside H	FN	125
	b	brucine	IA	131
	rb	condensamine	IA	132
	rb	11-methoxydiaboline	IA	132
	b	strychnine	IA	131
	rb	bis-nor-dihydrotoxiferine	IA	132

The abbreviations for the plant part are listed as follow :

b = bark, br = branch, ep = entire plant, fr = fruit, l= leaf, ns = not specified, peri = pericarp, rt = root, rb = root bark, rw = root wood, s = seed, sb = stem bark, st = stem, sw = stem wood, tb = trunk bark, tw = twig, w = wood

The abbreviations for the category are listed as follows :

AK = alkaloid, BZ = benzenoid, CB = carbohydrate, FN = flavonoid, IA = indole alkaloid, LP = lipid, MA = monoterpene alkaloid, MT = monoterpene, QA = quinoline alkaloid, ST = steroid, LN = lignan, TT = triterpenoid

THE *STRYCHNOS* ALKALOIDS

The phytochemical informations of the genus *Strychnos* suggest that the major constituents of the *Strychnos* species are the group of indole alkaloids. Thus, this species are considered to be the reservoir of the majority of indole alkaloids isolated from plants. Up till now, the number of the structurally known indole alkaloids are approximately 1,200.

The indole alkaloids derived from tryptamine and secologanin can be classified into 8 main skeletons which are corynanthean (C-type), vincosan (D-type), vallesiachotaman (V-type), strychnan (S-type), aspidospermatan (A-type), eburnan (E-type), plumeran (P-type), and ibogan (J-type).

Structure Classification of the *Strychnos* Alkaloids

The indole alkaloids belonging to the *Strychnos* species are comprised of 5 different skeletons, they are the C-, D-, V-, S-, and A-types. The most abundant indole alkaloids in the genus are the S-types while the C-types are the least.

According to Pingsuthiwong (1986)¹³³, the *strychnos* alkaloids can be divided into 2 main classes; monomeric indole alkaloids and bisindole alkaloids.

1. monomeric indole alkaloids

1.1 corynanthean (C-type)

C1 : E-*seco* indole group

usambarensine (1)

C2 : ajmalicine group

ajmalicine (2)

C3 : yohimbine group

yohimbine (3)

C4 : akagerine group

akagerine (4)

C5 : mavacurine group

mavacurine (5)

C6 : sarpagine group

sarpagine (6)

C7 : oxindole group

strychnofoline (7)

1.2 vincosan (D-type)

D1 : stryctosidine group

dolichantoside (8)

D2 : decussine group

decussine (9)

1.3 vallesiachotaman (V-type)

V1 : antirhine group

antirhine (10)

V2 : angustine group

angustine (11)

1.4 strychnan (S-type)

S1 : retuline group

retuline (12)

S2 : diaboline group

diaboline (13)

S3 : isostrychnine group

isostrychnine (14)

S4 : strychnine group

strychnine (15)

S5 : spermostrychnine group

spermostrychnine (16)

S6 : tsilanine group

tsilanine (17)

1.5 aspidospermatan (A-type)

A1 : condylocarpine group

condylocarpine (18)

1.6 miscellaneous (M-type)

M1 : ngouniensine group

ngouniensine (19)

M2 : olivacine group

ellipticine (20)

2. bisindole alkaloids

2.1 strychnan-strychnan (S-S type)

B1 : retuline-retuline group (S1-S1)

dihydrotoxiferine (21)

B2 : diaboline-diaboline group (S2-S2)

caracurine V (22)

B3 : retuline-diaboline group (S1-S2)

dolichocurine (23)

B4 : isostrychnine-isostrychnine group (S3-S3)

sungucine (24)

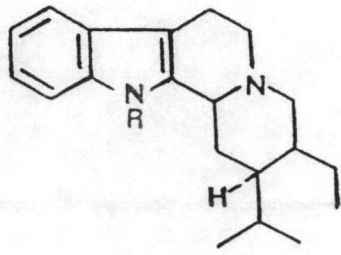
2.2 strychnan-corynanthean (S-C type)

B5 : diaboline-E-seco indole group (S2-C1)

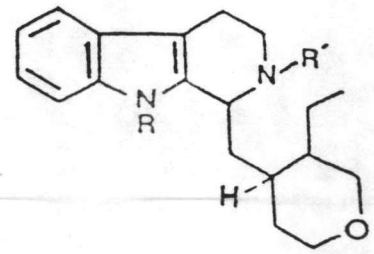
longicaudatine (25)



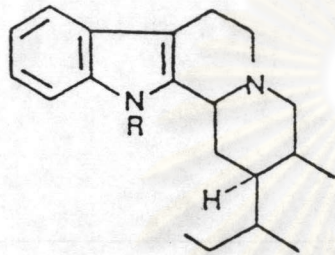
ศูนย์วิทยทรัพยากร
จุฬาลงกรณ์มหาวิทยาลัย



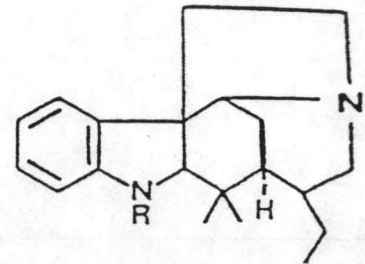
Corynanthean
(C-type)



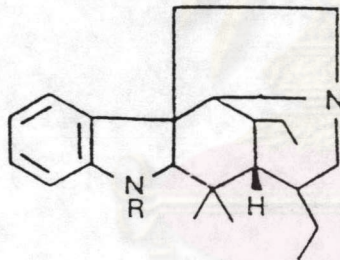
Vincosan
(D-type)



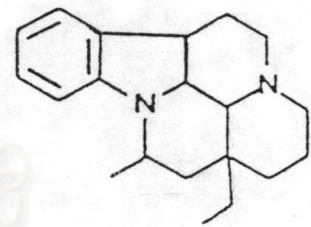
Vallesiachotaman
(V-type)



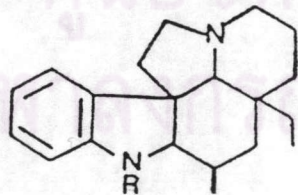
Strychnan
(S-type)



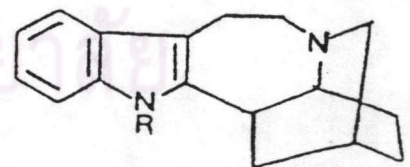
Aspidospermatan
(A-type)



Eburnan
(E-type)

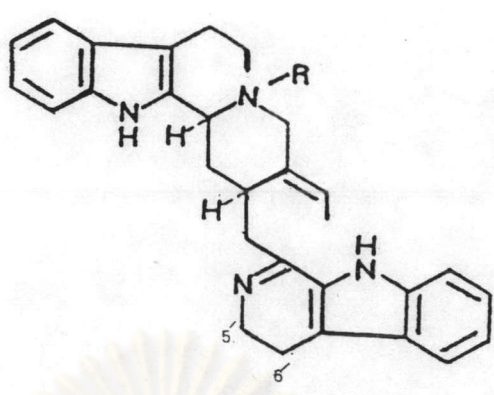


Plumeran
(P-type)



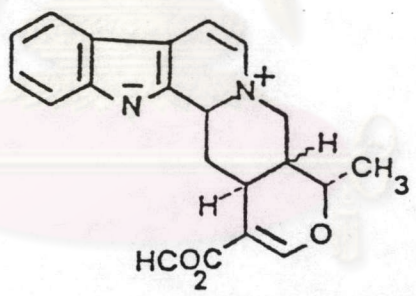
Ibogán
(J-type)

Figure 1 The indole alkaloid skeletons



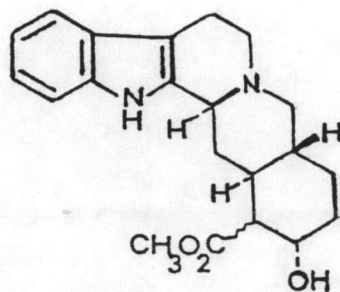
usambarensine (1)

(R = H ; Δ 5', 6')

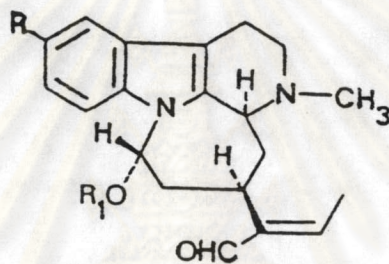


ajmalicine (2)

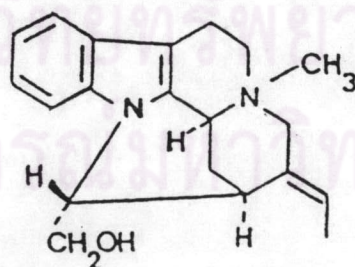
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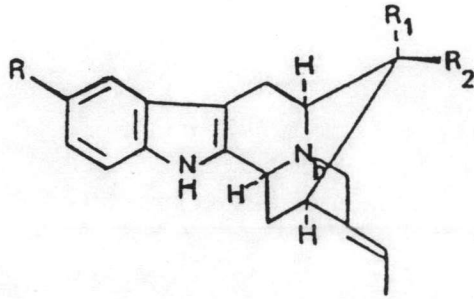
yohimbine (3)



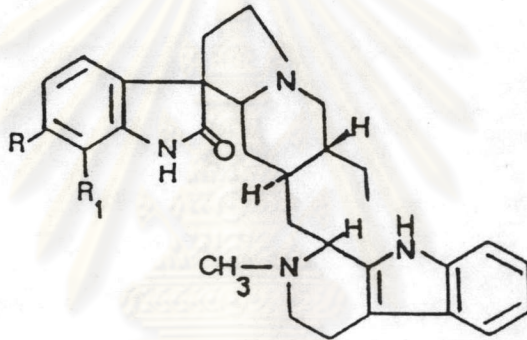
akagerine (4)

(R = R₁ = H)

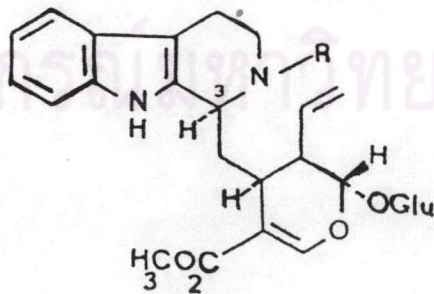
mavacurine (5)



sarpagine (6)

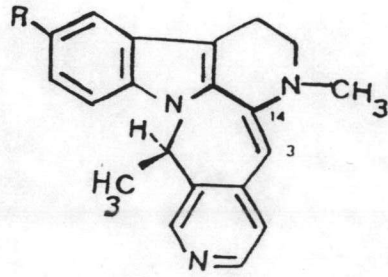
(R = OH, R₁ = H, R₂ = CH₂OH)

strychnofoline (7)

(R = OH, R₁ = H ; Δ 18,19)

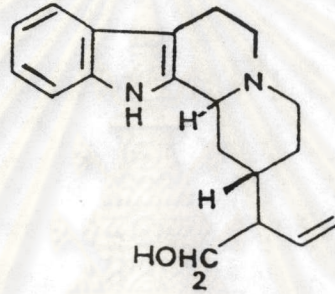
dolichantoside (8)

(R = CH₃ ; 3-α-H)

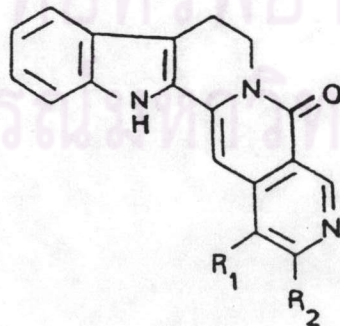


decussine (9)

(R = H)

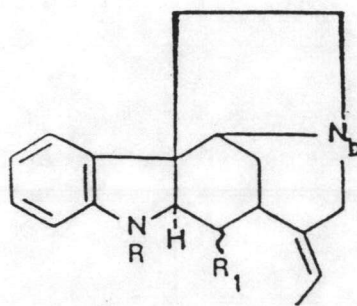


antirhine (10)



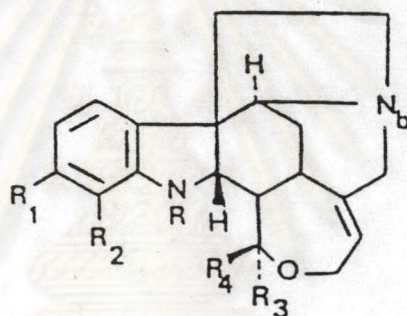
angustine (11)

(R₁ = H, R₂ = -CH=CH₂)



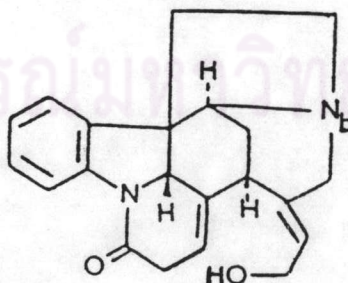
retuline (12)

(R = COCH₃ , R₁ = α-CH₂OH)



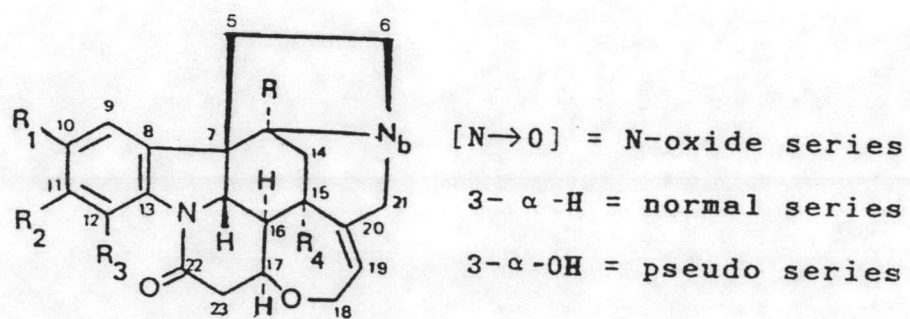
diaboline (13)

(R = COCH₃ , R₁ = R₂ = R₃ = H , R₄ = OH)

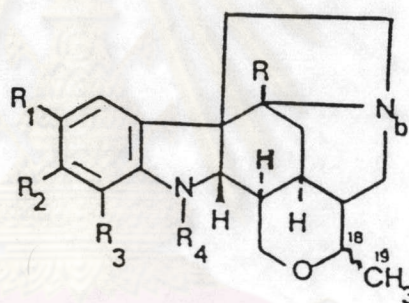
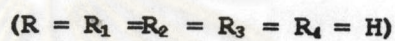


isostrychnine (14)

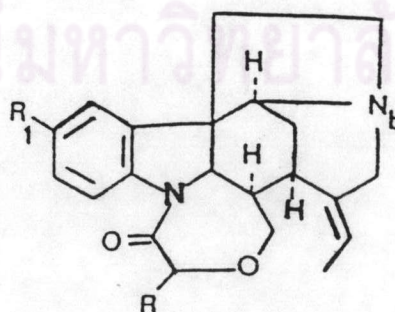
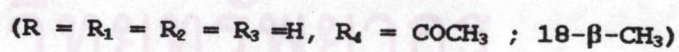
(Δ 19,20)



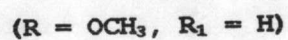
strychnine (15)

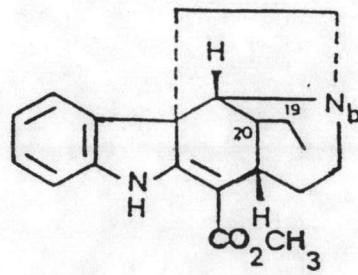


spermostrychnine (16)

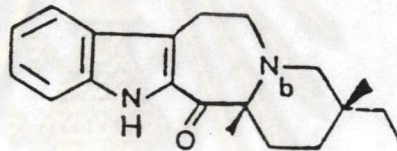


tsilanine (17)

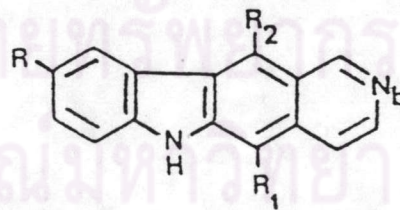




condylocarpine (18)

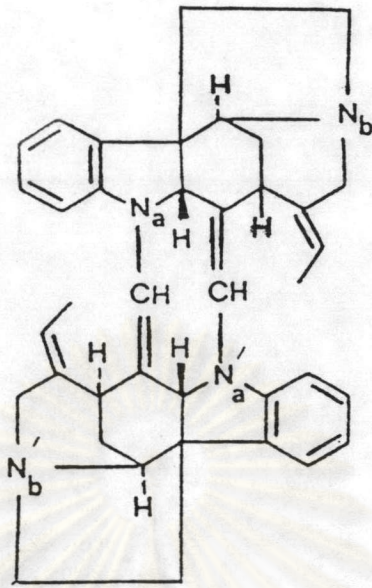
($\Delta 19,20$)

ngouniensine (19)

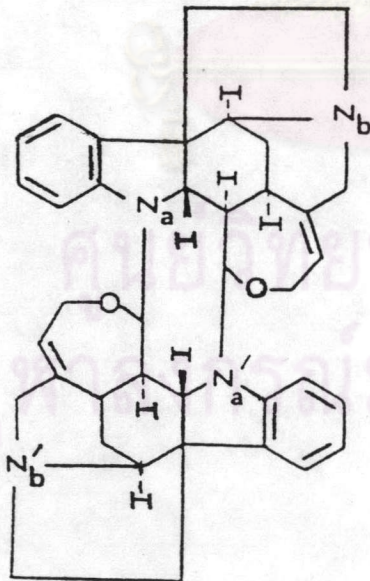


ellipticine (20)

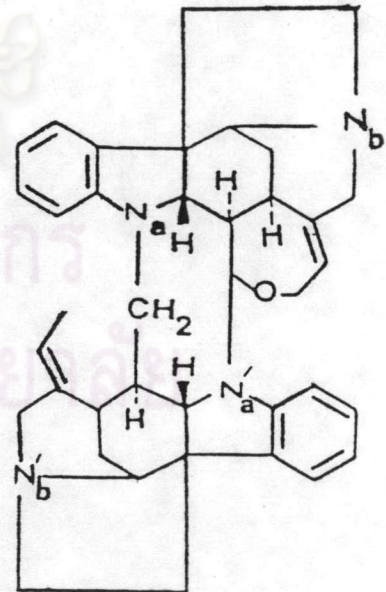
(R = H, R₁ = R₂ = CH₃)



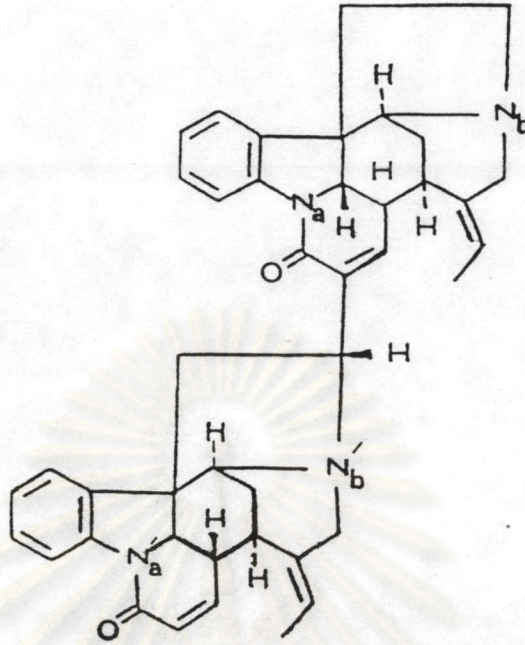
dihydrotoxiferine (21)



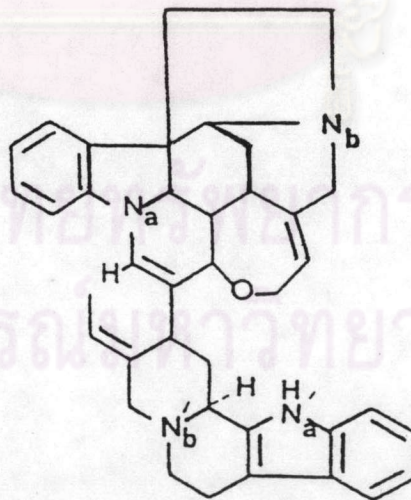
caracurine V (22)



dolichocurine (23)



sungucine (24)

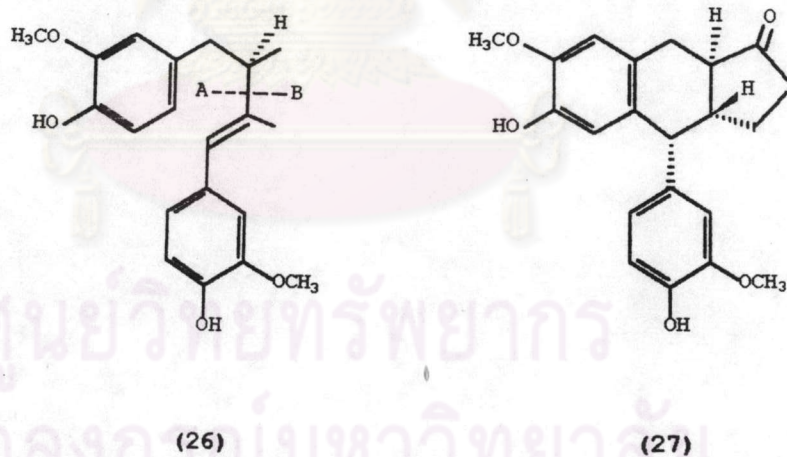


longicaudatine (25)

THE LIGNANS

Structure of Lignans

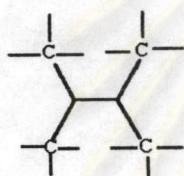
Lignans form a group of plant phenols whose structure is determined by the union of two cinnamic acid residues or their biogenetic equivalents. The unifying definition is illustrated by the structure of guaiaretic acid (26), in which the bar line separated the two β, β -linked cinnamic residues. Guaiaretic acid, with the terminal groups fully reduced, is structurally one of the simplest members of the group; while conidendrin (27) is more complex in that the terminal groups differ and are also at higher oxidation levels.



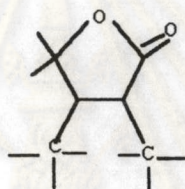
Other common variations occur naturally in which the aromatic substituents are modified in whole or in part to methylenedioxy and also where additional oxysubstitution takes place with or without O-methylation. No lignans has been isolated with an unsubstituted phenyl ring.

According to the way in which oxygen is incorporated into the skeleton, four structural groups of linear lignans can be recognized.¹³⁴

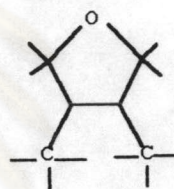
1. lignans, or derivatives of butane (28)
2. lignanolides, or derivatives of butanolide (29)
3. monoepoxylignans, or derivatives of tetrahydrofuran (30)
4. bis-epoxylignans, or derivatives of 3,7-dioxabicyclooctane (31)



(28)



(29)

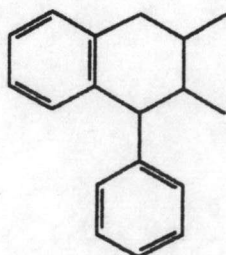


(30)

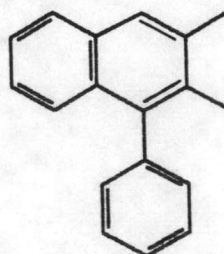


(31)

Further cyclization resulting from the introduction of a c-7 / C-6" linkage allows the existence of a large class of compounds collectively known as cyclolignans. These occur either as tetrahydronaphthalene (32) or naphthalene (33) derivatives.



(32)



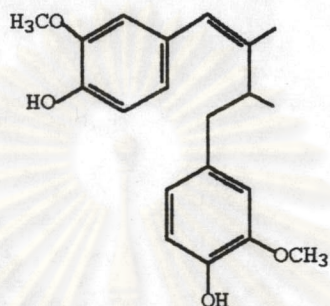
(33)

According to Ayres and Loike (1990)¹³⁵, and Devon and Scott (1975)¹³⁶, the naturally occurring lignans can be divided into 8 groups.

1. dibenzylbutanes

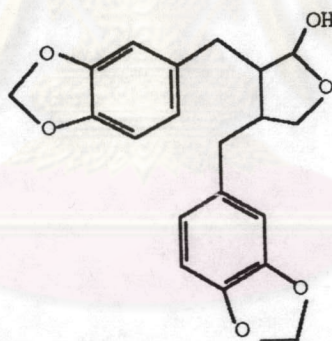
1.1 with unsubstituted side chains

such as : guaiaretic acid



1.2 oxygenated in the side chain

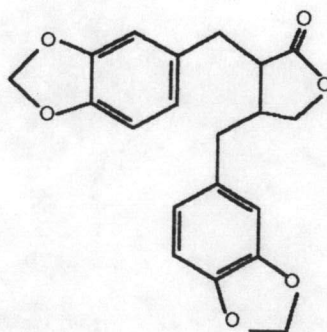
such as : cubebin



2. dibenzylbutyrolactones

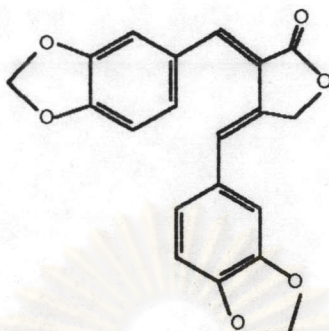
2.1 diarylbutyrolactones

such as : hinokinin



2.2 unsaturated diarylbutyrolactones

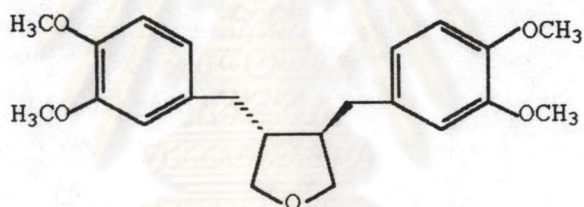
such as : taiwanin A



3. tetrahydrofurans

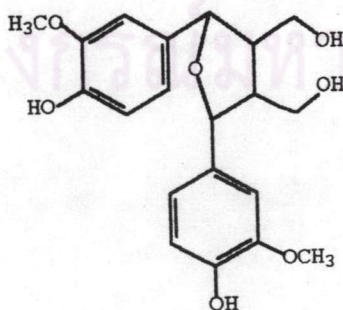
3.1 9,9'- epoxy lignans

such as : brassilignan



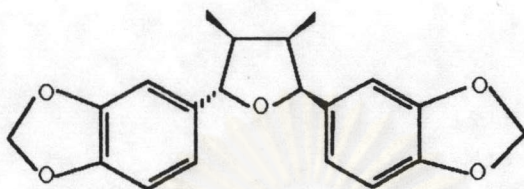
3.2 7,9'- epoxy lignans

such as : olivil



3.3 7,7'- epoxyignans

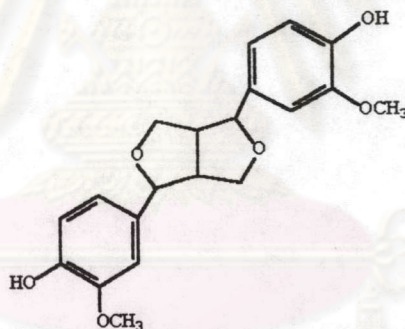
such as : chicanine



4. furofurans

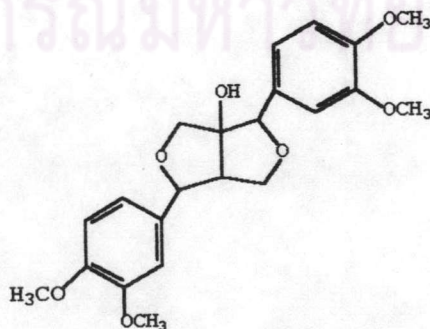
4.1 with unsubstituted side chain

such as : pinoresinol



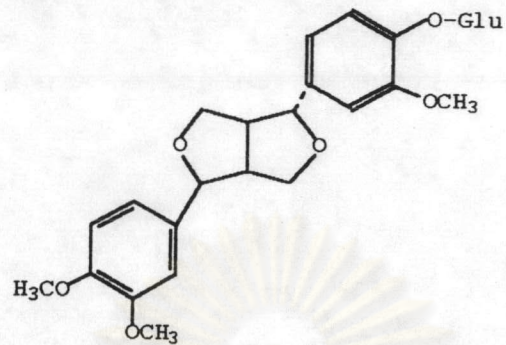
4.2 oxyfurofurans

such as : gmelinol



4.3 furofuran glycosides

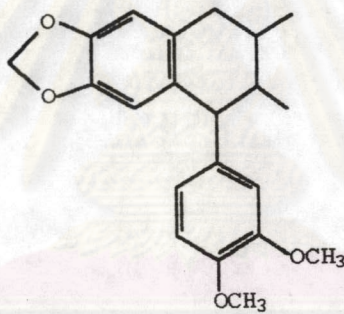
such as : phillyrin



5. aryltetrahydronaphthalenes (tetralin lignans)

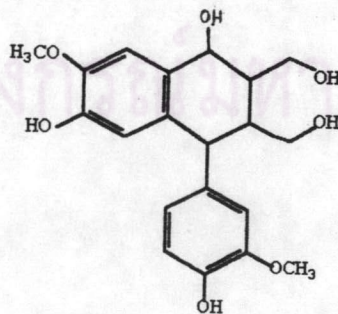
5.1 with unsubstituted side chain

such as : galcatin



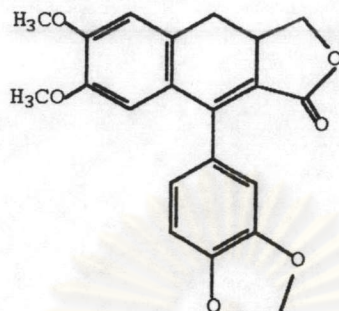
5.2 oxygenated in the side chain

such as : isoolivil



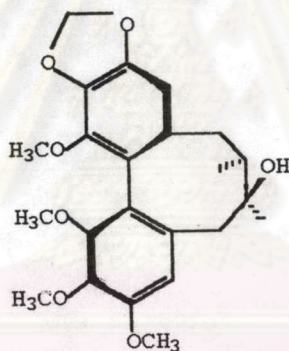
6. apolignans

such as : collinusin



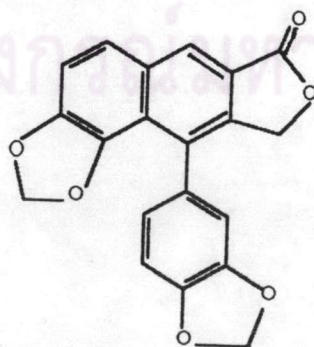
7. dibenzocyclooctadienes

such as : gomisin A



8. aryl-naphthalene lignans

such as : helioxanthine



Biosynthesis of Lignans¹³⁵

(figure 2)

The biosynthesis of lignans can be related to lignins. The direct evidence of lignan biogenesis assumed that dimerisation involved similar precursors and processes to those that had been demonstrated for lignin. The route to lignin depends on the shikimic acid - cinnamic acid pathway. The compounds in these pool were identified by the classical work of Davis (1958)¹³⁷, who showed that carbohydrates were converted into shikimic acid with subsequent branching to give either phenylalanine or tyrosine. It is significant to all work on lignan biosynthesis that these two branches are distinct and interchange between their components does not occur.

Tyrosine may give rise to *p*-coumaryl alcohol by the action of tyrosine ammonia lyase (TAL), but this route to lignin is not general in plants. The principal route to lignin and lignans follows the action of a lyase on phenylalanine to give cinnamic acid. Cinnamic acid was converted into *p*-coumaric acid by the action of phenolase. Experimental proof of the role of the alcohols, coniferyl, and sinapyl alcohol as the natural precursors of lignin which composed mainly of C₆-C₃ units. By the condensation of 2 or more C₆-C₃ units, lignans and other polyphenolic compounds are derived.

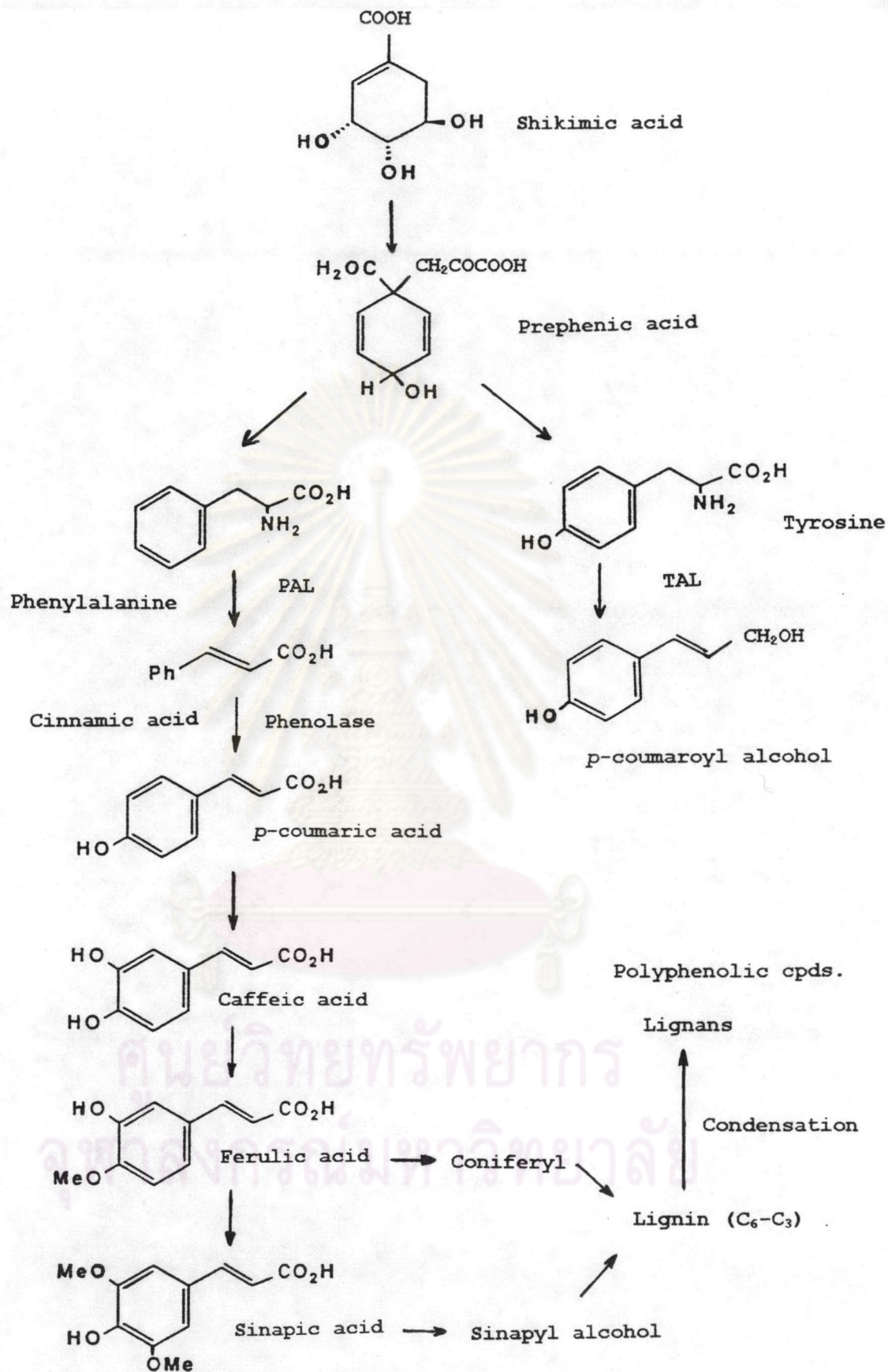
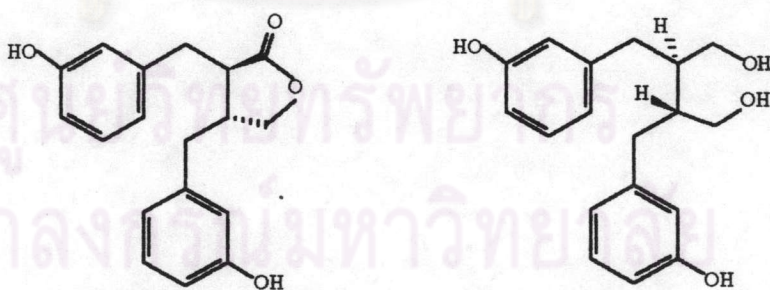


Figure 2 Biosynthesis of Lignans

Source of Lignans

Lignans have been isolated from all part of plants. In many of the gymnosperms in which they occur they are important constituents of the wood. They are also known from the wood of angiosperm trees. Some are present in tree bark , while resin is an especially good source in some case. They have been isolated from roots , leaves , flowers , fruits , and even seeds. In several cases , long term explants , maintained in tissue culture , have been shown to produce lignans.¹³⁴

A number of lignans have recently been identified in humans and in several animals. Both enterolactone and enterodiol have recently been described as the major lignans present in serum , urine , bile , and seminal fluids of humans and animals.¹³⁸ The mammalian - derived lignans differ from plant - derived lignans in possessing phenolic hydroxyl groups only in the *meta* position of the aromatic rings.



Enterolactone

Enterodiol

Distribution of Lignans

Lignans are widely distributed throughout the plant kingdom. Table 2 presents a list of the plant families, arranged systematically, from which lignans have been isolated. The phylogenetic arrangement is that of Cronquist (1981).¹³⁹ Fifty-five families of vascular plants are included. Gymnosperms are especially well represented, while the class Liliopsida, on the other hand, is represented by only a single grass, *Aegilops ovata* from which one lignan has been isolated. Lignan-containing plants are distributed throughout the six subclasses of the Class Magnoliopsida in an apparently random fashion. The widespread distribution of lignans suggests that they play an important role in plant evolution.

Table 2 Distribution of lignans in lower plants ¹³⁴

Division	Order	Family
Pterophyta	Filicales	Polypodiaceae
Coniferophyta	Coniferales	Pinaceae
		Cupressaceae
		Taxodiaceae
		Podocarpaceae
		Araucariaceae
		Taxaceae

Table 2.1 Distribution of lignans in higher plants ¹³⁴

Division Magnoliophyta			
Class	Subclass	Order	Family
Magnoliopsida	Magnoliidae	Magnoliales	Himantandraceae
			Magnoliaceae
			Winteraceae
		Austrobaileyaceae	
		Eupomatiaceae	
		Myristicaceae	
		Lurales	Hernandiaceae
			Lauraceae
		Piperales	Piperaceae
		Aristolochiales	Aristolochiaceae
		Illiciales	Schizandraceae
		Ranunculales	Berberidaceae
		Hamamelidae	Urticales
	Urticaceae		
	Caryophyllidae	Fagales	Fagaceae
			Betulaceae
	Dilleniidae	Caryophyllales	Phytolaccaceae
			Violales
			Cucurbitaceae
		Salicales	Salicaceae
	Ericales	Ericaceae	
	Ebenales	Styracaceae	
		Symplocaceae	

Table 2.1 (continue)

Division Magnoliophyta			
Class	Subclass	Order	Family
	Rosidae	Rosales	Rosaceae
		Fabales	Fabaceae
		Myrtales	Thymalaeaceae
			Myrtaceae
			Combretaceae
		Santalales	Loranthaceae
			Balanophoraceae
		Euphorbiales	Euphorbiaceae
		Linales	Linaceae
		Polygalales	Polygalaceae
		Sapindales	Burseraceae
			Anacardiaceae
			Rutaceae
			Zygophyllaceae
		Apiales	Araliaceae
			Apiaceae
	Asteridae	Gentianales	Apocynaceae
		Solanales	Solanaceae
		Lamiales	Verbenaceae
			Lamiaceae
			Phrymaceae

Table 2.1 (continue)

Division Magnoliophyta			
Class	Subclass	Order	Family
Liliopsida	Commelinidae	Scrophulariales	Oleaceae
			Scrophulariaceae
			Globulariaceae
			Acanthaceae
			Pedaliaceae
		Asterales	Asteraceae
		Cyperales	Poaceae

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Biological activity of lignans

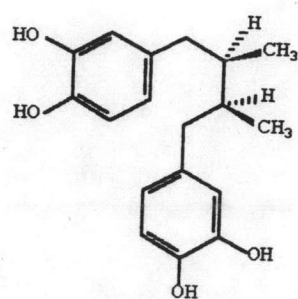
The recorded use of lignans as folk remedies dates back over 1,000 years. At present, lignans still play an important role in modern clinical medicine due to their diverse biological properties. Various lignans are known to have antitumor, antimitotic, and antiviral activity. Table 3 shows a list of lignans which possess cytostatic or antitumor activity.

Table 3 Lignans with known antitumor activity¹³⁴

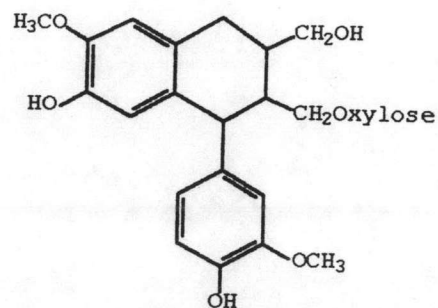
Compound	Structure number
Nordihydroguaiaretic acid	34
(+)-Dimethylsolariciresinol-2 α -xyloside	35
Burseran	36
(-)- <i>trans</i> -2-(3'',4'',5''-Trimethoxybenzyl)-3-(3',4'-methylenedioxybenzyl) butyrolactone	37.1
(-)- <i>trans</i> -2-(3'',4''-Dimethoxybenzyl)-3-(3',4'-methylenedioxybenzyl) butyrolactone	37.2
Podophyllotoxin	38.1
Deoxypodophyllotoxin	38.2
3'-Demethylpodophyllotoxin	38.3
4'-demethylpodophyllotoxin	38.4
5'-Desmethoxypodophyllotoxin (Morelsin)	38.5
α -Peltatin	38.6
β -Peltatin	38.7
β -Peltatin-A-methyl ether	38.8

Table 3 (continue)

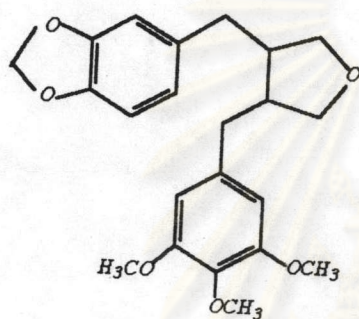
Compound	Structure Number
5'-Desmethoxy- β -peltatin-A-methyl ether	38.9
Podophyllotoxin glucoside	38.10
Picropodophyllotoxin	39
Epipodophyllotoxin	40
Picropodophyllic acid	41
Austrobailignan-1	42
Diphyllin	43.1
Justicidin-A	43.2
Diphyllin acetate	43.3
Diphyllinin	43.4
Diphyllinin monoacetate	43.5
Diphyllinin crotonate	43.6
Dehydroanhydropicropodophyllotoxin	44
Stegnacin	45.1
Stegnangin	45.2
Stegnanol	45.3
Stegnalone	45.4
Podophyllic acid ethylhydrazide (SP-1)	46
4'-Demethyl epipodophyllotoxin ethylidene- β -D-glucoside (VP-16-213 or Etoposide)	47.1
VM-26 (Teniposide)	47.2



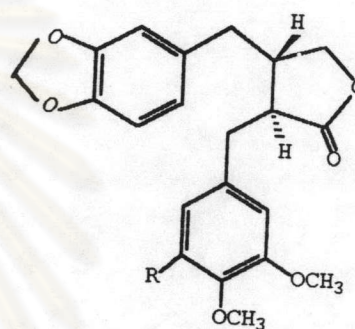
(34)



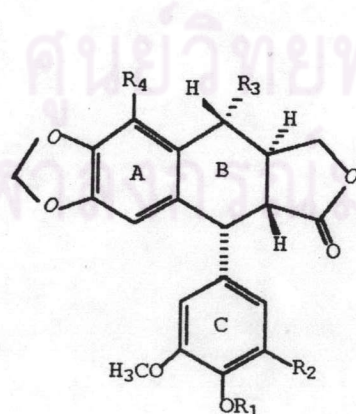
(35)



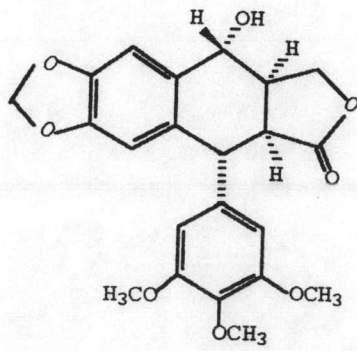
(36)

(37.1) R = OCH₃

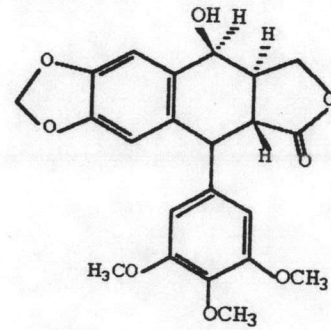
(37.2) R = H



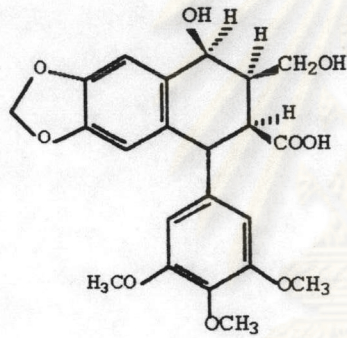
	R ₁	R ₂	R ₃	R ₄
(38.1)	CH ₃	OCH ₃	OH	H
(38.2)	CH ₃	OCH ₃	H	H
(38.3)	CH ₃	OH	OH	H
(38.4)	H	OCH ₃	OH	H
(38.5)	CH ₃	H	H	H
(38.6)	H	OCH ₃	H	OH
(38.7)	CH ₃	OCH ₃	H	OH
(38.8)	CH ₃	OCH ₃	H	OCH ₃
(38.9)	CH ₃	H	H	OCH ₃
(38.10)	CH ₃	OCH ₃	OGlu	H



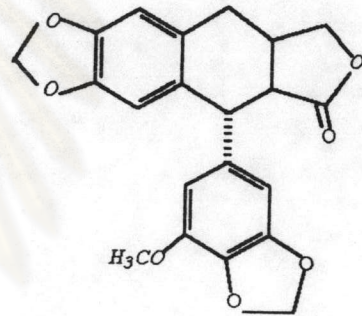
(39)



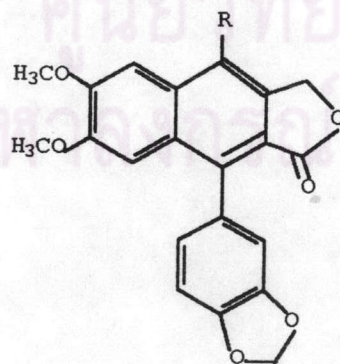
(40)



(41)



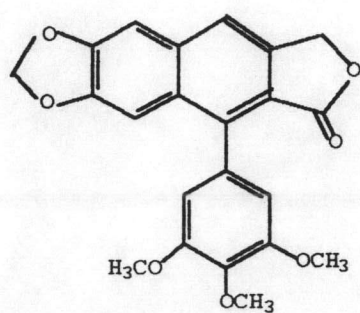
(42)



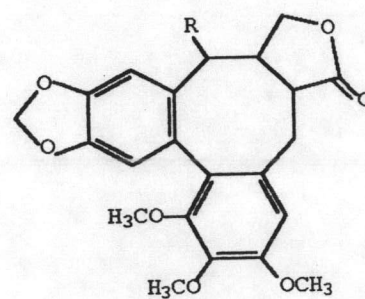
R

(43.1) OH

(43.2) OCH₃(43.3) OCOCH₃(43.4) OC₄H₄O(OH)₂CH₂OH(43.5) OC₄H₄O(OH)₂CH₂OCOCH₂(43.6) OC₄H₄O(OH)₂CH₂OCOCHCH₃



(44)



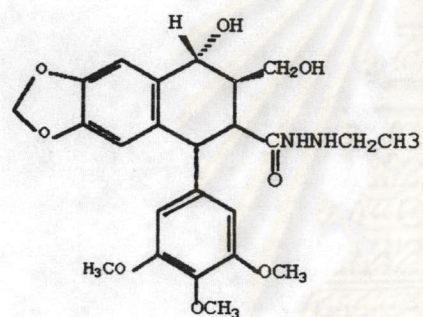
R

(45.1) OAc

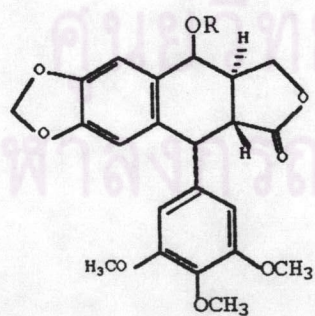
(45.2) $\text{OCO}-\text{C} \begin{matrix} \text{=CH}_2 \\ \text{CH}_3 \end{matrix}$

(45.3) OH

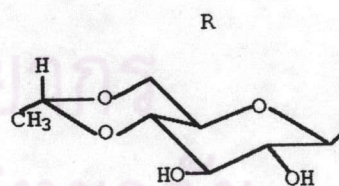
(45.4) =O



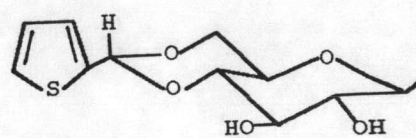
(46)



(47)



(47.1)



(47.2)

Podophyllotoxins (38.1), constituents of the medicinal resin extracted from *Podophyllum species*, are well-known for their antitumor activity . The application of podophyllotoxin in medicinal treatment is limited because of its severe gastrointestinal toxicity.

Etoposide (47.1) and Teniposide (47.2) are two semi-synthetic derivatives of podophyllotoxin , which were developed in 1970s in an attempt to develop antitumor agents which do not possess the severe gastrointestinal toxicity. Structure-activity relationship studies will be required for the rational development and design of new Etoposide derivatives with potentially greater antitumor activity and selectivity.



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