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Review

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A review of phytochemical studies of *Cassia* species

S. Ganapaty*, P. S. Thomas, K. V. Ramana, K. Vidyadhar, V. Chakradhar

Department of Pharmaceutical Sciences, Andhra University, Visakhapatnam, Andhra Pradesh - 530 003

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Abstract

A review of phytoconstituents and biological activities of *Cassia* species has been presented, considering the fact that there are about 580 species of this genus distributed all around the world. Only 46 species have been studied phytochemically. Hence an attempt is made to present a review on the phytochemical studies of *Cassis* sepcies which still remains as a potential source for bioactive molecules.

Key words: *Cassia* species, Phytochemical and pharmacological studies

1. Introduction

The genus *Cassia* (Fam: Leguminosae) comprises of 580 species of herbs, shrubs and trees, which are widely distributed throughout the world, of which only twenty species are indigenous to India [1]. Many of the *Cassia* spp. possess a good amount of medicinal properties and a few among them provide tanning materials, which are of great economic importance. The leaves of *C. alata* have been used throughout the ages for the treatment of ringworm infections, as a laxative and in the treatment of leprosy and syphilis [2].

The use of the leaves of *C.sophera* as an antidote for snake bites have been well documented in the Indian literature [3]. Venkatachalam in 1941 reported [4] the therapeutic applications of the leaves and the bark of *C. fistula* as a prominent laxative and also in the treatment of black water fever. Siddiqui *et al*. in the year 1935 established [5] the depressant activity of Chaksine, a constituent isolated from *C. absus* and also reported its effects on the heart and the nervous system. *Cassia angustifolia* [6,7] popularly called as senna is known for its anthraquinone glycosides and laxative action.

About 26 species of *Cassia* have been reported to contain anthracene derivatives either in their free form or as glycosides. The anthraquinone molecules are widely distributed in the genus *Cassia* and have remarkable biological properties. *C. angustifolia* and *C. acutifolia* are also included in the Pharmacopoeia due to their medicinal importance.

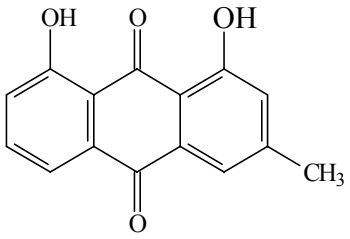
* Corresponding author
E-mail: ganapatyseru@yahoo.co.in

Encouraged by the overwhelming interest in the phytochemical investigation of this genus and the research work intermittently published on *Cassia* species it was felt worth while to present a phytochemical review of all the constituents reported so far from *Cassia* species along with their sources. This data is presented in Table-1.

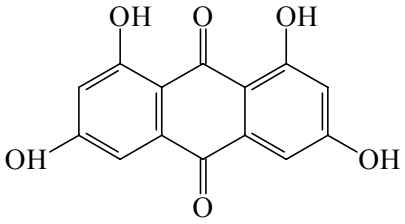
2. Biological activity

The *Cassia* species are considered to possess purgative [169], wound healing [170], anti-inflammatory [171] and hepatoprotective [172] properties. The anthraquinones obtained from the leaves and pods of *C.angustifolia* and *C. acutifolia* are classified as contact purgatives. They inhibit salt and water absorption in the colon and increase peristalsis, which results in soft and bulky faeces.

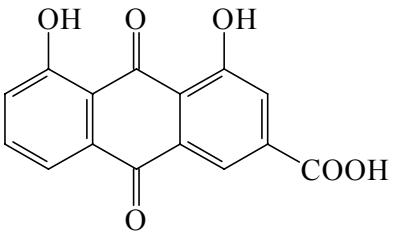
The literature reveals that rhein possesses significant purgative activity while chrysophanic acid-9-anthrone exhibited a good degree of fungicidal activity [173]. Sennosides are effective orally and are available as calcium salts. The anti-inflammatory activity of Cassia may be attributed to the flavonoid molecules present in them.



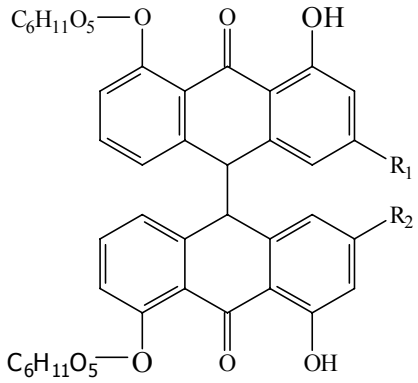
Chrysophanol



Emodin



Rhein



	R1	R2
Sennoside A	COOH	COOH (trans)
Sennoside B	COOH	COOH (meso)
Sennoside C	CH_2OH	COOH (trans)
Sennoside D	CH_2OH	COOH (meso)

Table 1.
List of compounds isolated from *Cassia* species

Species	Constituents Isolated	Ref.
C. absus	Raffinose (d)	8
	Chrysophanol (b)	9
	Aloe emodin (b)	9
	Quercetin (b)	9
	Rutin (b)	9
	Chaksine (b) (c)	9
	Isochaksine (b) (c)	9
	Palmitic acid (d)	10
	Gentisic acid (d)	10
	5-O-D-glucopyranosyl gentisic acid (d)	10
	Ethyl-α-D-galactopyranoside (d)	10
	Apigenin (d)	10
	Luteolin (d)	10
	Hydrocarpin (d)	10
	Isohydrocarpin (d)	10
C. abbreviata	2, 4-trans-7, 4' -dihydroxy-4-methoxy flavone	11
	Chrysophanol (b)	12
	Aloe emodin, lupeol (b) (c)	12
	β - sitosterol (b) (c)	12
	Stigmasterol (c) (b)	12
	Eicosanoic acid (c) (b)	12
	Octacosanol (c) (b)	12
	Decanoic acid (c) (d)	12
	Tetradecanoic acid	1
C. acutifolia	Chrysophanol (c)	13
	Physcion (c)	13
	Emodin (c)	13
	Aloe emodin (c)	13
	Rhein (c)	13
	Chrysophanein (c)	13
	Glucoate emodin (c)	13
	Emodin-8-O- β-gluco pyranoside (c)	13
	Sennidine (c)	13
	Glucorein (c)	13
C. alata	Rubrofusarin-6-O- β- D-glucopyranosyl - (1→3) - O - β - D glucopyranoside (b)	14
	Tetralactone-9-O- β- D-gluco pyranosyl- (1→6)-O- β-D-gluco pyranosyl (1→3)-O- β-D -leucopyranosyl - (1→6) - O - β - D - glucopyranosyl (b)	14
	Aloe emodin (b)	15
	Chrysophanol (b)	15
	Glycerol (d)	16

Species	Constituents Isolated	Ref.
	Erythritol (d)	16
	Alorone (a)	17
	Aliquinone (b)	18
	Alatonal (a)	19
	Alatinone (a)	20
C. angustifolia	1' -hydroxy - 3, 6, 7, 8 - tetramethoxy - 2 - isopropyl anthraquinone (d)	21
	1, 5,7,- trihydroxy - 8 - methoxy - 3 - Methyl anthraquinone (d)	21
	Kaempferol - 3 - O - β - glucoside	22
	Emoxin - 8 - O - sophoroside (d)	23
	6 – hydroxy musizin glycoside (d)	24
	5 hydroxy - 6, 8 dimethoxy - 2 methyl - 1 - O - β - D galactoside (c)	25
	Pelargonidin 5 - O - β - D - galactoside (c)	26
C. auriculata	7, 4" - dihydroxy flavone - 5 - O - β - O -galactopyranoside (f)	27
	Chrysophanol (f)	27
	Physcion (f)	27
	1, 5, 8 - tri hydroxy -6 methoxy - 2 - methyl anthraquinone - 3 - O - β - D -galactopyranosyl - (1→4) - O - β - D- manopyranoside (d)	28
	7, 4" - dihydroxy flavone - 5 - O - β -O -galactopyranoside (d)	28
	Fisetinidol - (4 a - 8") Catechin (d)	29
	Fisetinidol - (4 a - 8") Epicatechin (d)	29
	Fisetinidol - (4 a - 8") Gallaocatechin (d)	29
	Fisetinidol - (4 a - 8") Epi gallocatechin (d)	29
C. biflora	Chrysophanol (b)	30
	Physcion (b)	30
	Luteolin (b)	30
	Behenic acid (a)	31
	Myristic acid (a)	31
	Quibourtinidol - (4 α - 8") - epiafzeldin (a)	31
	Kaempferol - 7-O-[β - D - glactopyranosyl - (1→4) - α - L - rhamnopyranoside] (a)	32
	Quercetin - 3 – O - [β - D - glactopyranosyl - (1→6) - α - L - rhamnopyranoside] myricetin - 3 - O - α - L - rhamnopyranoside (a)	32
	4'-methoxy kaempferol - 3 - O - d - L - rhamnopyranosyl - 7 - O - β - D -xylopyranoside (a)	33
C. corymbosa (fruits)	Aloe emodin	34
	Chrysophanol	34
	Penduletin	34
	Quercetin	34
C. didymobotrya (Pods)	Didyronic acid	35
	Chrysophanol	35
	Physcion	35
	β-sitosterol	35
	Isorhamnetin	35
	Rhein	36

	Pauentinic acid	36
	Torosachrysone	36
	Emodin	37
	Knipholone	37
	10 - hydroxy-10-(physcion - 7'- yl) -1, 4 - anthraquinone	37
C. excelsa	Cassine (b)	38
	Cassilysine (b)	38
	Cassilysidine (b)	38
C. floribunda	Floribundone – I (b)	39
	Floribundone – II (b)	39
	Physcion, N; N^8 - dibenzoyl spermidine (b)	39
C. fastuosa	Sennosides A, B (b)	40
	Aloe emodin (b)	40
	Rhein (b)	40
C. fistula	3- formyl -1- hydroxy- 8 -methoxy anthraquinone (pods)	41
	1, 8- dihydroxy -6- methoxy- 3, 7 - dimethyl anthraquinone (c)	42
	Sennoside B	43
	3 - β - 17 norpimar- 8 (9)- en -15 -one (pods)	44
	Rhamnetin- 3- O- gentiobioside (c)	45
	5, 7, 3', 4' - tetrahydroxy - 6, 8- dimethoxy flavone -3 -O - α - arabinopyranoside 46 1, 8 -dihydroxy -3, 7 -dimethoxy xanthone - 4 -	
	O - α - L - rhamnosyl (1→2) - O - β - D- glucopyranoside (a)	46
	Aurantiamide acetate	47
	β - sitosterol β -D glucoside	47
	(-)- epiafzalechein (c)	48
	(-) - catechin (c)	48
C. grandis	1,7,8 - trihydroxy - 4 - methoxy -2- methyl anthraquinone - 3 - O- β - D - glucopyranoside. (pods)	49
	1,3,4, - trihydroxy - 4 - 6,7,8 - trimethoxy - 2- methyl anthraquinone 3-O - β - D - glucopyranoside. (pods)	50, 55
	Trans -3- methoxy-4, 5- methylenedioxyl cinnamaldehyde,(b)	51
	Aloe emodin (b)	51
	Catechin (b)	51
	Dihydroxy benzaldehyde,	51
	3, 4, 5- trimethoxy benzadehyde (b)	51
	1, 5, - dihydroxy- 8- methoxy -2, 3 - di methyl 9,10 anthraquinone (c)	52
	Kokusaginine	53
	Fabioline 1,1'- biperidine	53
	1, 3, 5, 8 - tetrahydroxy - 6, 7 - dimethoxy - 2 methyl anthraquinone (c)	54
	2 - O - β D - glucopyranosyl 1-1, 2, 4, 8 tetrahydroxy, 6 - methoxy - 3- methyl anthraquinone (d)	56
	1, 2, 4, 8 tetra hydroxy-6-methoxy - 3- methyl anthraquinone (d)	57
	3 - hydroxy - 6, 8 - dimethoxy - 2- methyl anthraquinone (d)	
	Kaempferol 3- O- β - D- mannopyranosyl - (1→ 4)-0- Glucopyranoside (d)	58
C. glauca	5, 7 - dihydroxy - 4' methoxy flavonol - 3- O - β - D galactopyranoside. (pods)	59

Species	Constituents Isolated	Ref.
	Chrysophanol (pods)	59, 62
	Pyscion (pods)	59
	Quercetin(pods)	59
	sitosterolin (d)	60
	Digitolutein (d)	60
	8-hydroxy-6-methoxy-3-methyl anthraquinone - 1- O - α - C-rhamnopyranosyl (1 - C - rhamnopyranosyl (1→6) - β - D - glucopyranoside (a)	61
	Stearic acid (c)	62
	β - sitosterol (c)	62
C. greggii	5- hydroxy - 1, 4, 6, 7 - tetramethoxy - 2- methyl anthraquinone (c)	63
	1, 5, 7 - trihydroxy - 2- methyl anthraquinone (c)	63
	1 -hydroxy-4, 7 - dimethoxy-5, 6-methylenedioxy 2- methyl anthraquinone	63
	5, 6 - dihydroxy - 4, 7 - dimethoxy 2- methyl anthraquinone. (c)	63
C. garrettiana	3, 3 - dihydroxy Benzyl (c)	64
	3, 3', 4, 5' - tetrahydroxy stilibene (c)	64
	Betulinic acid (c)	64
	Rhamnetin (c)	64
	Protocatecheuic aldehyde (c)	64
	Quercetin (c)	64
	Cassialoin (c)	65
	Cassigarol E (c)	66
	Cassigarol D (c)	66
	Cassigarol A (c)	67
	Cassigarol B (c)	67
C. hirsuta	Kaempferol- 3 O - α - L - rhamnopyranosyl (1 → 2)α -L-rhamnopyranoside (C)	68
	Kaempferol - 3 - O - rutinoside (c)	68
	Rutin (c) 68	
	4, 4' - bis (1,3,8- trihydroxy- 6 - methoxy- 2 - methyl anthraquinone (c)	69, 70
C. italica	Sennosides (b)	71
	Rhein glycosides (pods)	71
	Tamarixetin -3- rutinoside -7 - rhamnoside (b)	72
	1, 5 - dihydroxy -3- methyl anthraquinone (b)	73
	α -amyrin (b)	73
C. javanica	5, 3 dihydroxy -2 phenyl - 4 - chrome - 7, 4 - digulucoside (flowers)	74
	Naringenin - 7 - glucoside (flowers) 74 3 - glucoside of pelargonidin (flowers)	74
	1, 3, 4, 6 - tertrahydroxy- 5 - dimethoxy - 2 - methyl anthraquinone (a)	75
	1, 3, 5, 8 -tetrahydroxy -6 methoxy - 2 - methyl anthraquinone (a)	76
	Non acosane (b)	77
	Triacontane (b)	77
	Behenic acid (b)	77
	β-amyrin (b)	77

	Emodin (b)	77
	Kaempferol - 3 - O - β - D glucosyl - 6 - O - α - L - rhamnopyranose (b)	77
	Methyl mehenate (b)	77
	Tetracosane (b)	77
	Javanin (b)	78
	3', 6' dihydroxy - 4- methoxy chalcone (c)	79
	Peonidin-3- O - α - L (-) - rhamnopyranoside. (flowers)	80
	1, 6 - dihydroxy and 1, 5, 6 - trihydroxy - 3 - methyl anthraquinone. 8 - O - α - L - rhamnopyranoside (C)	81
C. laevigeta	3, 3', 5-trihydroxy - 4', 7 - dimethoxy flavone-3 - O - β - D (+) - galactopyranoside	82
	4-O - β - D - galactopyranosyl - (1 →4) - O - β - D -Manapyranose.	83
	Leucocyanidin - 7, 4' - O - dimethyl - 3- O - β - D- glucopyranose (a)	84
	Rhamnetin- 3 - galactosyl (1 → 4) galactopyranoside (a)	85
C. leptophylla	Leptophylla A (b)	86
	3 - acetyl leptophyllin A (b)	86
	(-) spectaline (b)	86
	Canaraline (b)	86
C.multiglandulosa	Torosachrysone (d)	87
	Floribundone (d)	87
	Anhydrophlegmacin (d)	87
	9-(physcion -7', 4')-5,10-dihydroxy-2-methyl - 7 - methoxy - 1, 4 anthraquinone (d)	87
	Emodin (d)	88
C. marginata	5, 7 -dihydroxy-6-methoxy flavone- 4' -O-neohesperidoside(c)	89
	5, 7 dihydroxy - 3', 4' - methylenedioxyl flavone (d)	90
	1, 3- dihydroxy - 6, 8- dimethoxy - 2- methyl anthraquinone 3 - O - rhamnosyl - (1 → 6) - glucopyranoside (c)	90
	Physcion - 1, 3 - dihydroxy - 2- methyl anthraquinone - 8 - O - α - arabinopyranoside (d)	91
	Emodin - 8- O - α - L - arabinopyranoside (d)	92
C. mimosoides	Calcium - 4 - O - β - D - glucopyranosyl - (Z) - p - coumarali (b)	93
	n - hentriacontanol (a)	94
	Chrysophanol (b)	94
C. muttijuga	5 - acetonyl - 7 - hydroxy - 2 - methyl chromone (b)	95
	5 - acetonyl - 6 - glycosyl - 7 - hydroxy - 20 methyl chromone (d)	96
	1, 3, 8- trihydroxy - 2 - methyl anthraquinone - 1 - O - rhamno pyranosyl - (1 → 6)-glucopyranoside (d)	97
C. montana.	Kaempferol (c)	98
	Quercetin (c)	98
	Kaempferol 3 - O- rutinoside (c)	98
	Rutin (c)	98
C. nomane	Demethyl torosaflavone C (a)	99
	Demethy torosaflavone D (a) (b)	99
	Luteolin (a) (b)	99

Species	Constituents Isolated	Ref.
	Vitexin (a) (b)	99
	Luteolin - 7 - glucoside (a) (b)	
	Physcion (d)	100
	Physcion - 9- anthrone (d)	100
	Emodin - 9 - anthrone	100
	Physcion - 10 (d)	100
	Chrysophanol (d)	100
C. nodosa.	Kaempferol - 3 - O - β - glucoside (b)	101
	2, 3 - dihydrokaempferol 3 - O- rhamnoside	101
	Quercetin - 3 - O - rhamnoside	101
	Emodin	101
	8 - c - glucosyl genestein (flowers)	102
	1, 4- dihydroxy -8 methoxy - 2 - methyl anthraquinone - 3 - O - β - D (+) glucopyranoside (c)	103
C. obtusifolia	Triacontan - 1- ol (b)	104
	Stigmasterol (b)	104
	Friedelin (b)	104
	Succinic acid (b)	104
	Uridine (b)	104
	Kaempferol (b)	104
	Quercetin (b)	104
	Juglanin (b)	104
	Cassioside B and Cassioside C (d)	105
	Rubrofusarin - 6 - O - gentiobioside (d)	105
	Betulinic acid (c)	106
	2, 5 - dimethoxy benzoquinone (c)	106
	Toralactone (c)	106
	Torosachrysone (c)	106
	Aloe emodin (c)	106
	Alaternin - 1 - O - β - D glucopyranoside (d)	107
	Isotorolactone (d)	108
	Cassialactone (d)	108
	Toroschrysene (d)	108
	1 - desmethyl chrysoobtusin (d)	109
	1 - desmethyl obtusin (d)	109
C. occidentalis	Occidentalol – I (c)	110
	Occidentalol – II (c)	110
	Chrysophanol (c)	110
	Emodin (c)	110
	Quercetin (c)	110
	Germichrysone (c)	110
	Methyl germitorosone (c)	110
	Singueanol (c)	110
	3, 5, 3', 4' - tetrahydroxy-7-methoxy flavone-3-O-(2" rhamnosylglucoside) (pods)	111

	Physicon (d)	112
	Rhein (c)	112
	Aloe emodin (c)	112
	Matteucinol - 7 - rhamnoside (b)	113
	Jaceidin - 7 - rhamnoside (b)	113
	1, 8 - dihydroxy - 2 - methyl anthraquinone (b)	114
	1, 4, 5 - trihydroxy - 7 - methoxy - 3 - methyl anthraquinone (b)	114
	Bianthraquinone (b)	115
C. podocarpa	Rhein glycoside (b)	116
	1, 8, dihydroxy - 3 - methyl - 9 - anthrone (flowers)	117
C. pudibunda	10 - demethyl flavasperone (c)	118
	10 - demethyl flavasperone - 10 - O - β - D - apiaferanosyl - 1 (1 → 6) - O - β - D - glucopyranoside (c)	118
	Rubrofusarin - 6 - O - β - D glucopyranoside (c)	119
	Quinquangulin - 6 - O - β - D - glucopyranaside (c)	119
	Chrysophanol dimethyl ether (c)	119
	Tetra triacantanol (a) (b) (c)	120
	Physcion (a) (b) (c)	121
	Hexacosanal (b)	122
	β - sitosterol (b)	122
	Rutin (b)	122
	Emodin (b)	122
C. peterriana	Colensanone (b)	123
	Colensenone (b)	123
C. roxburghii	Chrysophanol (a)	124
	Roxburghin (b)	125
	Terephathalic acid (a) (b)	125
	(-) epiafzelichin (a) (b)	125
	Roxburghinol (b)	126
C. renigera	α, β – amyrins (a)	127
	2 - hydroxy - 1, 6, 8 -trimethoxy anthraquinone (a)	128
	5-hydroxy-3', 4', 5', 6, 7-pentamethoxy flavone- 5-O-α-L-rhamnopyranoside (a)	129
C. siamea	β - sitosterol (b)	130
	Barakol (b)	130
	Apigenin (b)	130
	Cassia chromone (b)	131
	Chrysophanol (a)	132
	Physcion (a)	132
	1 - desmethyl chryso obtusin - 2- 0 glucoside (c)	132
	5, 7 - dihydroxy - 3', 4' - methylenedioxy flavone (b)	133
	2, 4', 5', 7 - tetrahydroxy - 8 - C - glucosyl isoflavone (b)	134
	19 α - 24 – dihydroxy urs - 12 ene - 28 - oic acid - 8 - O - β - D - xylopyranoside (a)	135
	Lup - 20 (29) - en - 1 β - 3 β - diol (a)	136
	4, 4' - bis (1, 3 - dihyroxy - 2 - methyl - 6, 8 - dimethoxy anthraquinone) (c)	137

Species	Constituents Isolated	Ref.
	1, 1' - bis (4,5- dihydroxy - 2 - methyl - 6, 8 - dimethoxy anthraquinone) (c)	137
	Siamin, siaminine A, B, C	138
C. sophera	9-(6'- methoxy-3'- methyl) - 3', 8', 9', 1, 4 anthraquinone (d)	139
	Physcion bianthrone (d)	140
	1, 8- dihroxy- 5, 7, 8 - trimethoxy - 2 - methyl anthraquinone (c)	140
	1, 8 – dihyoxy - 2 - methyl anthraquinone neohesperidose (c)	141
	Chrysophanol (c)	141
	Emodin (c)	141
	Sopheranin (c)	142
	3, 5, 6', 4', 5' - pentahydroxy - 7- methoxy flavone - 8C - rhamnopyranoside (c)	143
C. singurana	7 - methyl physcion (c)	144
	Cassanin A (c)	144
C. spectabilis	Chrysophanol (flowers)	145
	Pyscion (flowers)	145
	Emodin (flowers)	145
	Isorhamnetin - 5 - glucoside	145
	2 - methyl - 3- hydroxy - 6 (13 tetra decyl - acetyl piperidine)	145
	Kaempferol rhamnoside - 7 - O - glucoside (flowers)	145
	1, 8 - di hydroxy - 3 - methyl anthraquinone (flowers)	146
	6 – hydroxy - 4' - methoxy flavone - 6 - O - arabino pyranoside (d)	147
	Tetra triacontanyl patmitate (d)	148
	Cassinicine (a) (b)	149
	(-) – spectalinine (b)	149
	(-) - iso - 6 - carnavaline (d)	149
C. sesicordata	6, 8 - dihydroxy - 7 - acetyl - 1 - keto - 3 - methoxy - 4, 4 - dimethyl - 1, 4 -dihydro naphthalene (c)	150
C. tora	Alaternine (d)	151
	Nor - rubrofusarin - 6 - β - D - glucoside (d)	152
	Rubrofusarin - 6 - β - D gentiobiobioside (c)	152
	Brassinolide (d)	153
	Castasterone (d)	153
	Typhasterol (d)	153
	- 9 - (β- D - glucopyranosyl - 1 → 6) - O - β - D - glu - 1 one (d)	154
	2 - (β - D - glucopyranosyl oxy) - 8 - hydroxy - 3 - methyl - 1- methoxy - 9, 10 anthraquinone (d)	155
	3, 5, 8, 3', 4', 5' - hexahydroxy flavone (a)	156
	Basseol (a)	156
	Rhein (a)	156
C. torosa	Toroside A (b)	157
	Diosmetin 3' - O - β - D - glucopyranoside (b)	158
	Torsaflavone 3' - O - β - D glucopyranoside (b)	158
	Diosmetin (b)	158
	Luteolin (b)	158
	Phlegmacin A_2 and B_2 (d)	159, 160

	Anhydrophlegmacin (d)	159
	Torosaol - I and II (c)	160
	Quercetin (c)	160
	Sigueanol - I (c)	160
	Germichrysone (c)	161
	Torosaflavone D (b)	161
	Torosaflavone A and B (b)	162
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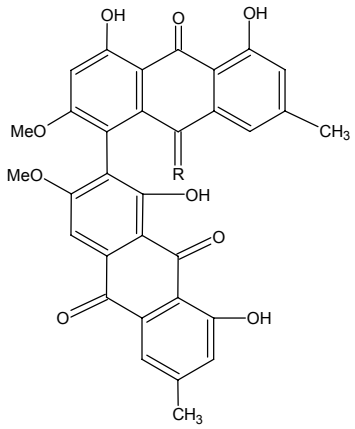
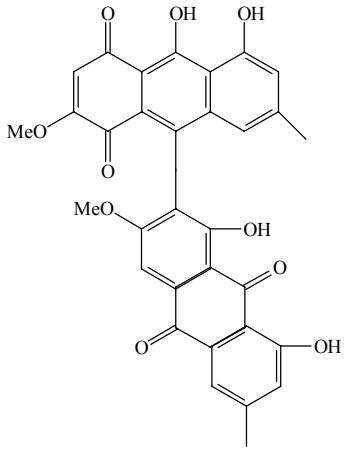
Stem (a); Leaf (b); Root (c); Seed (d); Flower (f)



Floribundone1, R=O; Floribundone 2, R=H



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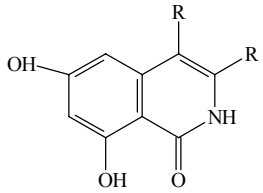
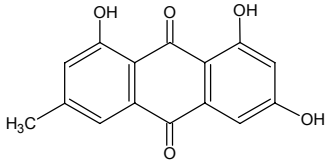


Siaminine A, R=Me; Siaminine B, R=H



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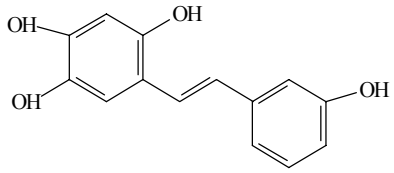

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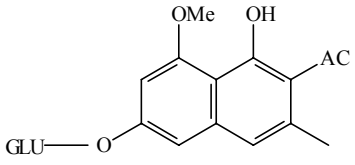

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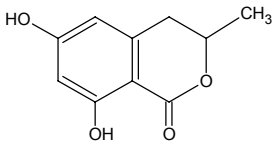

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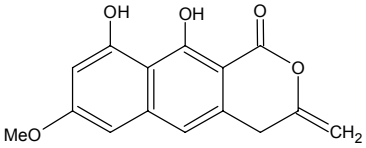

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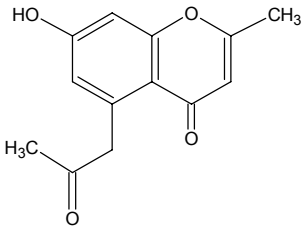
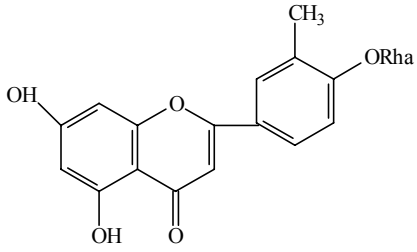


Cassiachromne



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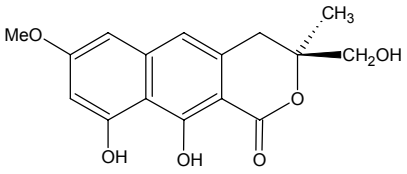

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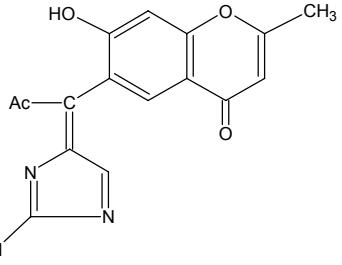
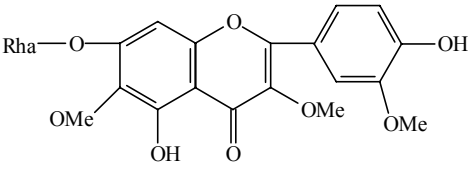
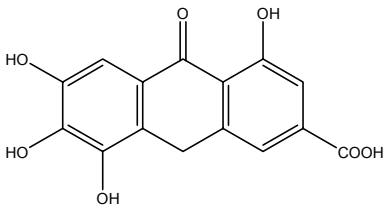


Cassiadinne



Jaceidin-7-rhamnoside



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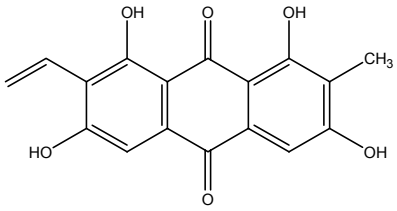

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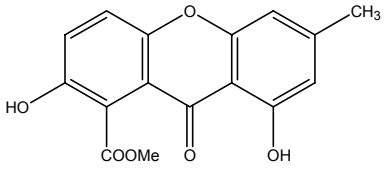

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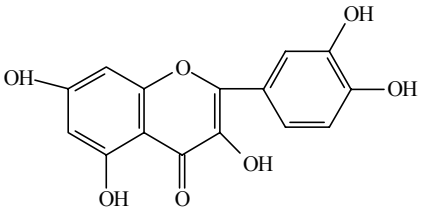

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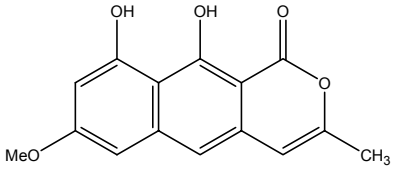
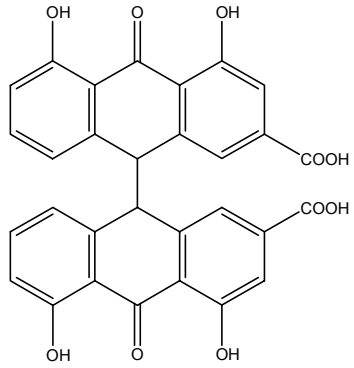


Toralactone



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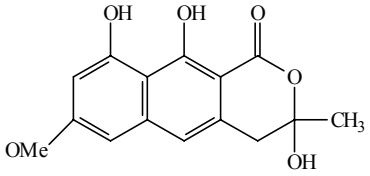
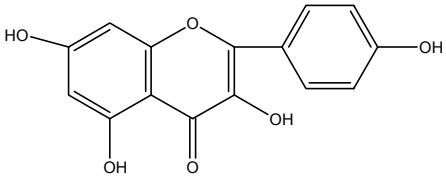


Cassialactone



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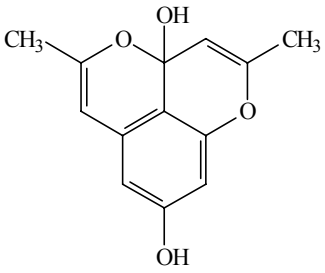

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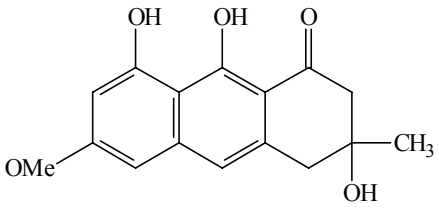
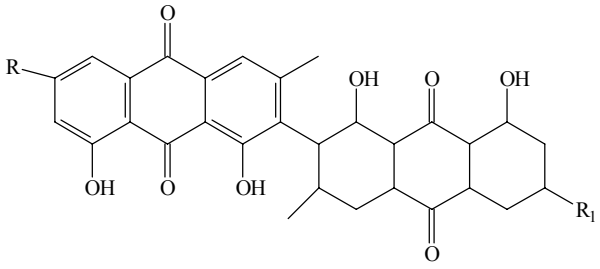
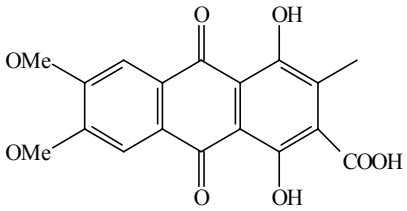


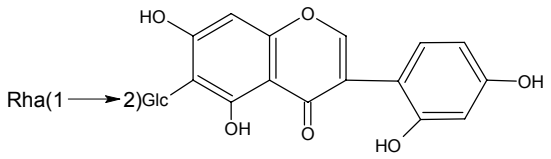
Torosachrysone



Cassiamin A-R=OH, R_1=H; Cassiamin B-R_1, R=OH; Cassiamin C-R, R_1=H



Fistulic acid



Nodosin

3. Conclusion

The *Cassia* species have been carefully studied for their phytoconstituents as well as for their biological activities. Out of 580 species of this genus distributed all around the world, just 46 species have been phytochemically investigated. Phytochemical work on this genus seems to be by no means exhaustive and there still remains a vital scope for study of active molecules. Emodin, chrysophanol and rhein are widely distributed throughout this genus which suggests that these compounds may be chemotaxonomic markers of the genus *Cassia.*

References

1. Anonymous (1950) *The Wealth of India. Raw Materials,* Vol II. CSIR: Delhi; 93-98.

2. Kritikar KR, Basu BC. (1918) *Indian Medicinal Plants,* Vol II, 2nd edn. Lalit Mohan Basu : Allahabad, India; 870.

3. Kritikar KR, Basu BD. (1918) *Indian Medicinal Plants,* Vol II, 2nd edn. Lalit Mohan Basu: Allahabad, India ; 864.

4. Venkatachalam K, Ratnagiriswaram. (1941) *Indian Med.Gaz.* 76: 211.

5. Siddique A. (1935) *Proc. Indian Acad. Sci.* 2A : 421.

6. Seshadri M. (1939) *Proc. Indian Acad. Sci.* 10A: 96.

7. Evans WC. (1996) *Trease and Evans' Pharmacognosy,* 14th edn. Harcourt Brace and Company Asia Pte Ltd; 235.

8. Kapadia, Zulekha, Fernandolouis. (1986) *J. Chem. Soc. Pak.* 8(3): 429 –30.

9. Krishna Rao RV, Seshagiri Rao JVLN, Vimala Devi. (1979) *J. Nat.Prod.* 42 (3): 299-300.

10. Kostora IN, Rangaswami. (1977) *Ind. J. Chem. Soc.* 15 (8): 764-765.

11. Tenuis, Guntenhoner, Matthical. (1998) *Phytochemistry.* 49 (6) : 1805-06.

12. Mutasa SL, Khan MR. (1995) *Fitoterapia.* 66, (2) : 184.

13. Kalashnikova GK, Romanova AS, Chavlinskii SG. (1995) *Khim-Farm Z A.* 19 (5): 569-73.

14. Kitanaka S, Nakayana T, Shibano T, Ohkoshi E, Takido M. (1998) *Chem. Pharm. Bull.* 46 (10) : 1650-1652.

15. Harrison J, Carroe, Verginia. (1979) *Rev. Peru. Bioguin.* 1(1): 31-32.

16. Singh RB. (1998) *Asian J. Chem.* 10 (1) : 185-186.

17. Hemalatha K, Suraj B.(1994) *Proc. Indian Natt. Sci. Acad.* 60 (6): 765-67.

18. Yadav, Satyender K, Kalidhar, Suraj B. (1994) *Planta. Med.* 60 (6): 601.

19. Hemalatha K, Suraj B. (1994) *Indian. J. Chem.* 33 (1): 92-3.

20. Hemalatha K, Suraj B. (1993) *Phytochemistry* 32 (6): 1616-17.

21. Gupta A, Siddiqui IR, Singh J, Sharma JP. (1998) *Indian J. Chem. Org. Chem. Incl. Med. Chem.* 37B (6) : 615-617.

22. Singh M, Chaudhuri PR, Sharma LP. (1995) *Fitoterapia* 66 (3) : 254.

23. Kinjo, Jumi, Ikeda, Tuyoshi, Watanabe, Kazutaka, Nohara, Toshiro. (1994) *Phytochemistry* 37 (6) : 1685-87.

24. Lemli J, Topper S, Cuveela J, Jansen G. (1981) *Planta. Med.* 43 (1) :11-17.

25. Rai KNK, Singh MP, Sinha, Binod K. (1994) *Asian J. Chem.* 9 (4) : 887-888.

26. Rai KN, Singh MP, Sinha, Binod K. (1994) *Asian J. Chem.* 6 (3) : 696-697.

27. Rai KN, Basaundhi RA. (1990) *J. Bangladesh Acad. Sci.* 14 (1) : 57-61.

28. Rai KN. (1993) *J. Bangladesh Acad. Sci.* 17 (1) : 119-24.

29. Nopi T, Corneli, Kaloga, Macki, Langhammer. (1990) *Liseololte.* P2 Wiss. 3 (4) : 157-59.

30. Hemalatha K, Suraj B. (1995) *Indian J. Pharm. Sci.* 57 (6) : 262.

31. Menna Rani, Kalidhar SB. (1998) *J. Indian Pharm. Soc.* 75 (6) : 386.

32. Ahmad M, Jam N, Kamil M, Ilyas. (1991) *Fitoterapia* 62 (4) : 347-80.

33. Jain, Neeru, Yadava RN. (1994) *J. Indian Chem. Soc.* 71 (4) : 209-11.

34. De Ruiz REL, Tusco M, Sosa A, Ruiz SO. (1996) *Fitoterapia* 67 (1) : 95.

35. Hemalatha K, Suraj B. (1997) *J. Indian Chem. Soc.* 74 (8) : 657.

36. Alemayehu, Gizachew, Abegaz, Berhane, Snatzkeg, Duddick H. (1989) *Bull. Chem. Soc. Etiop.* 3 (1) : 37-40.

37. Alemayehu, Gizachew, Hailu, Ayele, Abenaz, Berhanu. (1996) *Phytochemistry* 42 (5) : 1423-25.

38. Alemayehu,Gizachew, Ayele, Abenaz, Berhanu. (1987) *Planta. Med.* 21 (7) : 42-43.

39. Alemayehu, Gizachew, Abenaz, Berhanu M, Snatze G, Duddeck. (1998) *Phytochemistry* 27 (10) : 3255-8.

40. Krambeck, Reni, Moreina, Eduardo, Augusto, Leonart, Rubens, Miguel, Obdulio G. (1985) *Trib. Farm.* 53 (1) : 1-11.

41. Rani, Meena, Kalidhar SB. (1998) *Indian J. Chem. Org. Chem. Incl. Med. Chem.* 37B (2) : 1314-1315.

42. Das C, Jogi SR. (1998) *Orient J. Chem.* 15 (1) : 145-146.

43. Chowdhury S, Alan C, Mustafa AKM, Alan MN, Gofur MA, Ray BK, Ahmed, Farug O. (1996) *J. Sci. Indian Res.* 31 (2) : 91-97.

44. Missra TN, Singh RS, Pandey HS, Singh BK. (1997) *Fitoterapia* 68 (4) : 375-376.

45. Voushav MM, Gupta KR. (1996) *Fitoterapia* 67 (1) : 78-79.

46. Gupta V, Agarwal, Anulya, Tiwari HP. (1989) *Indian J. Chem.* 28B (3) : 282-284.

47. Biswak KM, Mallik, Haimanti. (1986) *J. Ind. Chem. Soc.* 63 (4) : 448-449.

48. Patil AD, Desphande VH. (1982) *Indian J. Chem. Soc.* 21B (7): 626-628.

49. Verma, Rajeshwar Prasad, Sinha, Kripa Shanker. (1996) *Fresinius Environ. Bull.* 5 (5/6) : 253-257.

50. Verma RP, Sinha KS. (1996) *Int. J. Pharmacog.* 34A : 290-294.

51. Gonzalez AG, Bernejo J, Valencia E. (1996) *Planta. Med.* 62 (2) : 176-177.

52. Ambasta BK, Prasad G, Sinha KS, Verma RP. (1996) *Indian J. Chem. Sec-B, Org. Chem. Ind. Med. Chem.* 35B (9) : 990-991.

53. Valencia E, Modinavutia A, Bernejo J, Gonzalez AG, Gupta MP. (1995) *Fitoterapia* 66 (5) : 476-477.

54. Verma, Rajeshwar Prasad, Sinha, Kripa S. (1995) *Indian J. Chem. Sec-B, Org. Chem. Incl. Med. Chem.* 34B (1) : 75.

55. Verma RP, Sinha KS. (1994) *Nat. Prod. Lett.* 5 (2) : 105-110.

56. Singh M, Siddiqui IR, Gupta B, Singh. (1992) *Pol. J. Chem.* 66 (3) : 469-475.

57. Siddiqui, Ibaduv R, Singh, Mithiles, Gupta, Dipti S, Jagadamba. (1993) *Nat.Prod. Lett.* 2 (21) : 83-90.

58. Srivasthava YS, Gupta PC. (1981) *Planta. Med.* 41 (4) : 400.

59. Rai KN, Kaushalendra, Kumar, Singh, Janardhana. (1997) *Asian J. Chem.* 93 : 558-560.

60. Khare GC, Dixit AK, Gupta PC. (1994) *Natt. Acad. Sci. Lett.* 17 (1-2) : 21-23.

61. Rai KN, Roy RA. (1991) *J. Bangladesh Acad. Sci.* 15 (2) : 193-198.

62. Hemalatha K, Suraj B. (1994) *Indian J. Pharm. Sci.* 5 (61) : 33-34.

63. Gonzalez, Antonio G, Bermejo, Barrera, Jaime, Barba D, Bertha,Valencia, Emir, Dominguez, Xorge A. (1992) *Phytochemistry* 31 (1) : 255-258.

64. Hata, Kiyoshi, Baba Kimye, Kozawa, Mittsugi. (1979) *Chem. Pharm. Bull.* 27(4) : 984-999.

65. Kiyoshi H, Kimye B, Mistsugi K. (1978) *Chem. Pharm. Bull.* 26 (12) : 3792-3799.

66. Takashi, Marda, Kaeru, Taniguchi, Massicho. (1992) *Phytochemistry* 31 (9) : 3215-3218.

67. Kimiye B, Kororu M, Yuko T, Mitsunobu D, Mitsugi K. (1988) *Chem. Pharm. Bull.* 36 (8) : 2977-2983.

68. Rao KV, Damu AG, Jayaprakasam B, Gunasekhar D. (1999) *J. Nat. Products.* 62(2): 305-206.

69. Singh J, Singh J. (1985) *Int. Conf. Chem. Priotechnol. Biol. Act., Nat Prod.* (Proc.) 3rd edn. (1987) 5 : 171-174.

70. Singh J, Singh J. (1986) *Phytochemistry* 25 (8) : 1985-1987.

71. Jain SC, Sharma RA, Jain R. (1996) *Fitoterapia* 67 (1) : 82.

72. El-Sayeed, Nabil H, Abu, El-Khrusy, Jon J. (1992) *Phytochemistry* 31 (6) : 2187.

73. Kazmi, Mehdi, Malik, Abdul, Hamned, Saika, Akhtar, Margis, Ali, Samina Noor. (1994) *Phytochemistry* 36 (3) : 761-763.

74. Pervez M, Obgeride, ON, Irshad K, Ashfag A. (1995) *Pak. J. Sci.* 47 (1-2) : 34-37.

75. Sinha K, Verma RP. (1994) *Indian J. Chem.* 33B (2) : 203.

76. Singh J, Singh J. (1988) *Indian J. Chem.* 27B (9) : 858-859.

77. Chawdhri K, Chawla HM. (1985) *Indian J. Pharm. Sci.* 47 (4) : 172-173.

78. Chakraborthy, Kakoli, Chawola H, Mohindra, Rastogi DK. (1984) *Indian J. Chem.* 23B (6): 543-545.

79. Tiwari RD, Singh J. (1978) Symp. Pap-IVPAC, *Int. Symp. Chem. Nat. Prod.* 11 (2) : 313-315.

80. Singh J. Tiwari AR, Tiwari RD. (1979) *J. Indian Chem. Soc.* 56 (7) : 746.

81. Tiwari RD, Singh J. (1979) *Phytochemistry* 18 (5) : 906.

82. Tiwari RD, Singh J. (1978) *Planta. Med.* 34 (3) : 319-332.

83. Singh RB. (1990) *Actacienc. Indica Chem.* 16C (1) : 93-100.

84. Singh J, Agarwal S. (1981) *J. Nepal Chem. Soc.* 1 (1) : 68-74.

85. Singh J. (1982) *Phytochemistry* 21(7) : 1832.

86. Bolzani, Venderlan Das, Gunatilaka AA, Leslie, Kingston, David GI. (1995) *Tetrahedron.* 51 (21) : 5929-5934.

87. Alemayehu, Gizachew, Abegaz, Berhanu M. (1996) *Phytochemistry* 41(3) : 919-921.

88. Aleegaz, BerhaauM, Bezabeh, Merhatibebi, Alemayehu, Gizachew, Duddeck. (1994) *Phytochemistry* 35(2) : 52-54

89. Rai KN, Shrivastava KM, Thakur DN. (1993) *J. Indian Chem. Soc.* 70 (3) : 271-272.

90. Gupta V, Agarwal, Amulaya, Singh HP. (1989) *Indian J. Chem.* 28B (1) : 92-94.

91. Duggal J, Kaur, Yadava VS, Misra K. (1982) *Proc. Natt. Sci.* 52 (2) : 189-193.

92. Duggal J, Kaur, Misra K. (1982) *Planta. Med.* 45 (1) : 48.

93. Udea, Minoru, Ohnuki, Takashi, Yamamura, Shosuke. (1998) *Phytochemistry* 49 (3): 633-635.

94. Mukherjee KS, Bhattacharya P, Mukherjee RK, Gosh PK. (1986) *J. Indian Chem. Soc.* 36 (6) : 619.

95. Singh J. (1981) *Pol. J. Chem.* 55 (5) : 1181.

96. Singh J. (1992) *Phytochemistry* 21 (5) : 1177.

97. Singh J. (1981) Planta. Med. 41 (4) : 397.

98. Kumar K, Pratap, Nia, Mokhtar Ali, Gunasekhar References (1991) *Indian J. Nat. Prod.* 7 (1) : 18-19.

99. Kitanaka S, Takido M. (1992) *Phytoche-mistry* 31 (8) : 2927-2929.

100. Kitanaka S, Takido M. (1985) *J. Nat. Prod.* 48 (5) : 849.

101. Ilyas M, Praveen M, Khan MS. (1995) *Fitoterapia* 66 (3) : 277-278.

102. Ilyas M, Praveen M, Khan MS, Kanil. Mohammed J. (1994) *Chem. Res. Sylop.* 3 : 88.

103. Sinha LS, Durivedi N, Sinha SK. (1986) *J. Bangladesh Acad. Sci.* 102 : 203-207.

104. Matussura, Shim, Yoshioko, Shiro, Linuma P Kazu. (1978) *Yokugaku Zasshi.* 989 : 1288-1291.

105. Kitanaka S, Takido M. (1988) *Chem. Pharm. Bull.* 3610 : 3980-3984.

106. Kitanaka S, Takido M. (1986) *Yakugaku Zasshi.* 1064 : 302-306.

107. Kitanaka S, Kimura T, Takido M. (1985) *Chem. Pharm. Bull.* 333 : 1274-1276.

108. Kitanaka S, Takido M. (1981) *Phytochemistry* 208 : 1951-1953.

109. Kitanaka S, Takido M. (1984) *Chem. Pharm. Bull.* 323 : 860-864.

110. Kitanaka S, Takido M. (1989) *Chem. Pharm. Bull.* 372 : 511-512.

111. Singh, Mithilesh, Singh J. (1985) *Planta. Med.* 6 : 525-526.

112. Rai PP, Shok M. (1983) *Indian J. Pharm. Sci.* 452 : 87-88.

113. Tiwari RD, Singh J. (1977) *Phytochemistry* 167 : 1107-1108.

114. Lal J, Gupta PC. (1974) *Experientia* 308 : 850-851.

115. Tiwari RD, Singh J. (1977) *Planta. Med.* 32 (4) : 375-377.

116. Rai PD, Obayeni OM. (1978) *Curr. Sci.* 47 (13) : 457.

117. Rehman S, Parvez M, Ogbeide ON, Rehman, A. (1994) *Pak. J. Sci.* 56 (34) : 9891.

118. Messana, Irene, Ferrari. Franco, Salete. (1990) *Heterocycles.* 31 (10) : 1847-1853.

119. Messana, Irene, Ferrari, Franco, Cavalcanti MSB, Morace, Giulia. (1991) *Phyto-chemistry* 30 (2) : 708-710.

120. Mukherjee KS, Chakraborthy CK, Chatterjee JP, Bhattacharya P. (1989) *J. Indian Chem. Soc.* 66 (1) : 66-67.

121. Fataui F. Tahir, Hussaini FA, Shoeb B. (1986) *Fitoterapia* 57 (4) : 271.

122. Sharma, K Neelam, Gupta RR. (1983) *Indian J. Pharm. Sci.* 45 (6) : 253-255.

123. Mionthi, Jerome D. (1984) *Planta. Med.* 50 (1) : 114.

124. Ashok D, Sarma PN. (1987) *J. Indian Chem. Soc.* 64 (9) : 559-561.

125. Reddy P, Puronotham, Ashok D, Sarma PN. (1990) *J. Indian Chem. Soc.* 67 (9) : 783-784.

126. Ashok D, Sarma PN. (1985) *Phytochemistry* 24 (11) : 2673-2675.

127. Aeri, Vishu, Zafar R. (1991) *Indian Drugs* 29 (3) : 136-137.

128. Rani, Meena, Kalidhar SB. (1997) *Heterocycl. Chem.* 7 (2) : 161-162.

129. Tiwari RD, Bajpai, Meera. (1977) *Phytochemistry* 16 (6) : 789-789.

130. Krishna Rao RV, Narayana Reddy M. (1978) *Curr. Sci.* 47 (1) : 621-622.

131. Wagner, Hilderbert, El-Sayyad, Sarina Mohammaed, Seligamann. Oho,Chari VM. (1978) *Planta. Med.* 33 (5) : 258-261.

132. Abdulah OM, Davurish FMM, El-Sayyad. (1994) *Bull. Tac. Pharm.* (Cairo Univ.) 32 (3) : 391-393.

133. Jogi SR, Das C. (1998) *Orient. J. Chem.* 14(1) : 25-27.

134. Shafiullah M, Parvee M, Kamil M, Ilyas M. (1995) *Fitoterapia* 66 (5) : 439-441.

135. Singh, Hemalatha J, Agarwal, Babita. (1994) *Int. J. Pharmacogn.* 32 (1) : 65-68.

136. Tripathi AR, Paliwal MR, Singh J. (1992) *Fitoterapia* 63 (6) : 566.

137. Singh J, Sharma JP. (1992) *Phytochemistry* 31 (6) : 2176-2177.

138. EL Sayyed, Samia-H, Ross, Sannis A, Sayeed. (1984) *J. Nat. Prod.* 47 (4) : 708-710.

139. Alemayehu, Gizachew, Abegas, Berhanu, Kraus, Wolfgang. (1998) *Phytochemistry* 48A : 699-702.

140. Das A, Joshi T, Shukla S. (1984) *Phyto-chemistry* 23 (11) : 2689-2691.

141. Joshi T, Das A, Pandey S, Shukla S. (1985) *Phytochemistry* 24 (12) : 3073-3074.

142. Malhotra, Mishra, Krishana. (1982) *Planta. Med.* 46 (4) : 247-249.

143. Tiwari RD, Bajpai M. (1981) *Indian J. Chem.* 20B (5) : 437-438.

144. Mutasa SL, Kahn MR, Jeveerss K. (1990) *Planta. Med.* 56 (2) : 244-245.

145. Backshert, Enaan Y, El-Sayyad, Saniall (1992) Bull. 7ac. Sci.Assist Univ. 21(2) : 129-138.

146. Ashok D, Sarma PN. (1988) *Indian J. Chem.* 27B (9) : 862.

147. Singh M, Singh J. (1985) *Z. JaturFirsch. B. An Org. Chem.* 40B (4) : 550-552.

148. Singh. Mithilesh, Singh J. (1984) *Z. NaturFursch. B. An Org. Chem.* 39B (10) : 1425-1426.

149. Christo Fidia I, Welter A, Jadot J. (1977) *Tetrahedron.* 33 (22) : 3005-3006.

150. Delle M, Giuliano, Botta, Bruno, De Me Souuza, Maria Aleves de Mello, Jox Francisco, Gaes-Baitza Eszter. (1989) *Tetrahedron Lett.* 30 :45.

151. Lee HJ. Chai Jai, S Jung, Jee H Kang, Samsit. (1998) *Phytochemistry* 49 (5) : 1403-404.

152. Chei, Jai Sue, Dec, Hee Jung, Kaug, Sam Sik. (1994) *Arch. Pharmacol. Res.* 17 (6). 43-45.

153. Park, Reum-Hyumg, Park, Jong-Dai, Hyum, Jyu-Harum, Nakayanna, Masayoshi, Yokata Takao. (1994) *Bio-Sci. Biotechnol. Biochem.* 58 (7) : 1343-1344.

154. Wong Sui. Ming; Wong, Mary. M, Schigmann, OHO, Wagner, Hildibert. (1989) *Planta. Med.* 55 (3) : 276-280.

155. Wong SM, Wong, Mary M, Schigmann OHO, Wagner, H. (1988) *Phytochemistry* 28 (1) : 211-214.

156. Chakraborthy, Kakoli, Chawla H. Mohindra. (1983) *Indian J. Chem. Soc.* 22B (11) : 1165-1166.

157. Kitanaka S,Takido M. (1995) *Phytochemistry* 39 (3) : 717-718.

158. Kitanaka S, Takido M. (1992) *Chem. Pharm. Bull.* 40 (1) : 249-251.

159. Takahashi S, Kitanaka S, Takido M. (1977) *Phytochemistry* 16 (7) : 999-1002.

160. Kitanaka S, Takido M. (1990) *Chem. Pharm. Bull.* 38 (5) : 1292-1294.

161. Kitanaka S, Takido M. (1991) *Chem. Pharm. Bull.* 39 (12) : 3254-3257.

162. Kitanaka S, Ogata K, Takido, M. (1989) *Chem. Pharm. Bull.* 37 (9) : 2441-2444.

163. Kitanaka S, Takido M. (1984) *Chem. Pharm. Bull.* 32 (9) : 3436-3440.

164. Kitanaka S, Takido M. (1985) *Chem. Pharm. Bull.* 33 (11) : 4912-4915.

165. Kitanaka S, Takido, M. (1982) *Phyto-chemistry* 21(8) : 2103.

166. Sayeed HM. (1991) *Bull. Fac. Sci. Assist. Univ.* 20 (1) : 115-124.

167. Gritsanapan W, Tanti S, Bansung, Jira W, Vichiara. (1984) *J. Sci. Soc. Thailand.* 10 (3) : 189-190.

168. Ogura M, Cardell, Geoffery A. (1977) *Lloydia.* 40 (4) : 347-351.

169. Rai PP. (1979) *Curr. Sci.* 48 (1) : 15.

170. Bhakta T, Mukherjee, Pulok K, Kakoli, Pali M, Saha BP. (1998) *Nat. Prod. Sci.* 4 (2) : 84-87.

171. Palanisamy S, Nagarajan S. (1990) *Fitoterapia* 61 (1) : 44-47.

172. Maity, Tapan K, Manalal, Subash C, Pal M, Saba BP. (1998) *Nat.Prod. Sci.* 4 (4) : 226-229.

173. Ram P. Rastogi, Mehrotra BN. (1970-79) *Compendium of Indian medicinal Plants,* CDRI Publications: Lucknow; 147-156.