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PHYTOCHEMISTRY OF THE GENUS *PIPER*

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Key Word Index—*Piper*; Piperaceae; alkaloids; amides; propenylphenols; lignans; neolignans; terpenes; steroids; kawapyrones; piperolides; chalcones; dihydrochalcones; flavones; flavanones.

Abstract—The secondary metabolites isolated from *Piper* species for the period 1907 to June 1996 have been reviewed. Nearly six hundred chemical constituents belonging to different classes of bioactive compounds are listed together with their source(s) and references. © 1997 Elsevier Science Ltd

INTRODUCTION

The genus *Piper* belongs to the Piperaceae and has over 700 species distributed in both hemispheres. They are erect or scandent herbs, shrubs or infrequently trees. The *Piper* species have high commercial, economical and medicinal importance. Economically the Piperaceae is important for the pepper in the worldwide spice markets. The ripened fruit of *P. nigrum* is the source of white pepper, while the unripe fruit of the same species is the source of black pepper. A narcotic beverage is produced in Oceania from the roots of *P. methysticum*. Several species of *Piper* are grown domestically as house plants for their foliage.

Piper species, widely distributed in the tropical and subtropical regions of the world are used medicinally in various manners. Plants belonging to the genus *Piper* are reputed in the Indian Ayurvedic system of medicine for their medicinal properties [1, 2] and in folklore medicine of Latin America and West Indies. Chloroform extract of the stems of *P. aborescens* was found to display significant activity against a KB cell culture system and a P-388 lymphocytic leukemia system in cell culture [3]. In Jamaica, of the eleven *Piper* species known, *P. aduncum* and *P. hispidum* are listed as remedies for stomach aches and as insect repellents [4]. *P. amalago*, distributed from Mexico to Brazil is used to alleviate chest pains and as anti-inflammatory agent [5]. *P. sylvaticum roots* are used as an effective antidote to snake poison in the indigenous system of Indian medicine. *P. chaba* roots and fruits find numerous applications in medicine. In particular they are useful in asthma, bronchitis, fever, pain in abdomen, as stimulant and in haemorrhoidal afflictions [6]. *P. brachystachyum* shows insecticidal properties [7], whereas *P. futokadsura* is a medicinal plant that grows in Fuchein and Taiwan Provinces. The stem of *P. futokadsura*, known as haifengteng is widely used in the Chinese herbal medicinal prescriptions for the treatment of asthma and arthritic conditions; the benzene extract of its leaves showed anti-feedant activity against the larvae of *Spodoptera litura* F [8]. The West African blackpepper (*P. guineense*) is a woody climber distributed throughout West Africa, its fruits have been used as a flavorant, while preparations of leaves, roots and seeds have been used internally as medicinal agents for the treatment of bronchitis, gastrointestinal diseases, venereal diseases and rheumatism. The preparations obtained from the seed kernels have been used for their counter irritant and insecticidal properties [9]. An extract of the black pepper shows carcinogenesis in mice. The evidence of malignant tumours and of multiple tumours was greater

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in the pepper treated mice than in vehicle treated mice [10]. The petrol and dichloromethane extracts of the leaves and stems of *P. falconeri* have shown insecticidal activity against *Musca domestica* (flies) and *Aedes aegyptii* (mosquitoes) [11]. The dichloromethane extract of *P. acutisleginum* has also been reported to show insecticidal activity against *Musca domestica* and *Aedes aegyptii* [12]. The extract of *P. betle* has shown antihypertensive activity and that of *P. acutisleginum* has shown activity as inhibitor of aflatoxin B_1-DNA binding (unpublished results from our Laboratories).

The chemistry of *Piper* species has been widely investigated and the phytochemical investigations from all parts of the World have led to the isolation of a number of physiologically active compounds viz. alkaloids/amides, propenylphenols, lignans, neolignans, terpenes, steroids, kawapyrones, piperolides, chalcones, dihydrochalcones, flavones and flavanones. We are actively working on phytochemical investigations of Indian *Piper* species with an aim to develop biodegradable insecticidal compounds and antitumour drugs. Compounds isolated from Indian *Piper* species [13] and from *Piper* species in general [14] have been reviewed previously, but since the last review (published in 1987 [14]), at least 30 new species have been investigated. The lack of a comprehensive review on this subject prompted us to gather information on the different classes of secondary metabolites isolated from different *Piper* species. Special emphasis has been put on biological activities of the different classes of compounds. Various compounds isolated from different *Piper* species (upto June 1996) have been classified under twelve categories, viz. alkaloids/amides, propenylphenols, lignans, neolignans, terpenes, steroids, kawapyrones, piperolides, chalcones and dihydrochalcones, flavones, flavanones and miscellaneous compounds and are listed in Tables 1–12.

ALKALOIDS/AMIDES

Piperine (**112**) [15] was the first amide to be isolated from *Piper* species. Lee *et al.* [16] while doing a pharmacological study on piperine reported that it displayed central nervous system depressant (antagonism of electroshock induced seizures and muscle relaxation in mice), antipyretic (typhoid vaccinated rabbits), analgesic (taildip presence and writhing in mice) and antiinflammatory (carrageenan-induced edema in rats) activities. Miyakado *et al.* [17] isolated pipericide (**111**) from *P. nigrum* which showed insecticidal activity against the adzuki bean weevil (*Callosobruchus chinensis*). A mixture of pipericide (**111**), dihydropipericide (**28**) and guineensine (**55**) isolated from *P. nigrum* was shown to be toxic to male adult adzuki bean weevils in bioassay [18]. Kiuchi *et al.* [19] isolated seven amides from *P. nigrum* which showed larvicidal activity against second stage larvae of *Toxocara canis*. (2*E*,8*E*)-*N*-9-(3,4-Methylenedioxyphenyl)nonadienoylpiperidine (**88**) isolated from *P. nigrum* was reported to cause dilation of the heart in rabbits [20]. An amide, dehydropipernonaline (**27**) that has coronary vasorelaxant activity was isolated from the fruit of *P. longum* [21]. The structures of piperolactam B (**118**) and piperolactam D (**120**) have recently been revised [12] by us. By X-ray, spectral and synthetic studies we have shown that piplartine and piperlongumine are the same compounds and have the structure **124** [22].

Aduncamide (**1**), a new amide isolated from *P. aduncum* showed antibacterial activity against *Bacillus subtilis* and *Micrococcus luteus* [23]. It also showed cytotoxic activity towards KB nasopharyngal carcinoma cells. Recently six amide alkaloids of *P. guineense* were tested for anti-feedant activity against fifth instar larvae of chilopartellus [24]. Piperine (**112**) and $\Delta^{\alpha,\beta}$-dihydropiperine (**29**) exhibited the most potent antifeedant activity, $\Delta^{\alpha,\beta}$-dihydrowisanine (**33**) and trichostachine (**139**) were intermediate in activity followed by wisanine (**145**). The (2*E*,4*E*)-*N*-isobutyleicosadienamide (**65**) was the least active. Thus it was concluded that the presence of a methylenedioxyphenyl and an alicyclic amide group in the compound may be crucial for high antifeedant activity. Recently *N*-formylnoraporphines, formouragine (**51**) and *N*-formylnornuciferine (**52**) have been isolated by us from *P. argyrophylum* [25]. Although these types of alkaloids are known from Annonaceae family [26–28], this is the first reported occurrence of *N*-formylaporphines from the genus *Piper*. Various alkaloids/amides which have been isolated so far from *Piper* species are listed in Table 1.

Table 1. Alkaloids/amides from *Piper* species

Compound	Plant(s)	Reference(s)
Aduncamide (**1**)	*P. aduncum*	[23]
Alatamide (**2**)	*P. guayranum*	[29, 30]
Aristolactam A II (**3**)	*P. attenuatum*	[31]
	P. boehimerifolium	[31]
	P. hamiltonii	[31]
	P. longum	[31, 32]
Auranamide (**4**)	*P. aurantiacum*	[33]

Table 1—*continued.*

Compound	Plant(s)	Reference(s)
Aurantiamide (**5**)	*P. aurantiacum*	[34, 35]
Aurantiamide acetate (**6**)	*P. aurantiacum*	[34, 35]
	P. sylvaticum	[36]
Aurantiamide benzoate (**7**)	*P. aurantiacum*	[37]
(±)-*N*-Benzoylphenylalanine (**8**)	*P. aurantiacum*	[36]
Brachyamide A (**9**)	*P. brachystachyum*	[38, 39]
Brachyamide B (**10**)	*P. brachystachyum*	[38, 39]
	P. nigrum	[19]
Brachystamide A (**11**)	*P. brachystachyum*	[40]
Brachystamide B (**12**)	*P. brachystachyum*	[40]
Brachystine (**13**)	*P. brachystachyum*	[38, 39]
Cepharadione A (**14**)	*P. acutisleginum*	[41]
	P. argyrophylum	[25]
	P. attenuatum	[31]
	P. auritum	[42]
	P. betle	[41]
	P. boehimerifolium	[31]
	P. hamiltonii	[31]
	P. longum	[31, 43]
	P. manuausense	[44]
	P. methysticum	[45]
	P. pedicellosum	[46]
	P. sanctum	[47]
	P. wightii	[48]
Cepharadione B (**15**)	*P. aborescens*	[49]
	P. argyrophylum	[25]
	P. attenuatum	[31]
	P. auritum	[42]
	P. boehimerifolium	[31]
	P. hamiltonii	[31]
	P. longum	[31, 32]
	P. sanctum	[47]
	P. wightii	[48]
Cepharanone B (**16**)	*P. argyrophylum*	[25]
	P. attenuatum	[31]
	P. boehimerifolium	[31]
	P. chiadoense	[49]
	P. longum	[31, 32]
	P. wightii	[48]
3-Chloro-4-hydroxy-2-piperidone (**17**)	*P. hancei*	[50]
N-Cinnamoylpyrrole (**18**)	*P. argyrophylum*	[51]
N-Cinnamoylpyrrolidine (**19**)	*P. argyrophylum*	[25]
	P. methysticum	[105]
	P. schmidtii	[53]
	P. wightii	[48]
N-*p*-Coumaroyltyramine (**20**)	*P. argyrophylum*	[25]
Cyclobutane-2-(1,3-benzodioxol-5-methoxy-6-yl)-4-(1,3-benzodioxol-6-yl)-1,3-dicarboxapyrrolidide (**21**)	*P. peepuloides*	[54]
Cyclobutane-2,4-bis(1,3-benzodioxol-5-methoxy-6-yl)-1,3-dicarboxapyrrolidide (**22**)	*P. peepuloides*	[54]
Cyclopiperstachine (**23**)	*P. trichostachyon*	[55]

Table 1—*continued.*

Compound	Plant(s)	Reference(s)
Cyclostachine A (**24**)	*P. trichostachyon*	[55, 56]
Cyclostachine B (**25**)	*P. trichostachyon*	[55]
2,4-Decadienoylpiperidine (**26**)	*P. chaba*	[57]
Dehydropipernonaline (**27**)	*P. longum*	[58]
Dihydropipericide (**28**)	*P. nigrum*	[18, 39]
$\Delta^{\alpha,\beta}$-Dihydropiperine (**29**)	*P. guineense*	[59, 60]
	P. novae hollandiae	[61]
4,5-Dihydropiperlonguminine (**30**)	*P. amalago*	[62]
	P. guineense	[59, 63]
	P. longum	[64]
	P. tuberculatum	[65]
8,9-Dihydropiplartine (**31**)	*P. bartlingianum*	[66]
	P. rugosum	[67]
$\Delta^{\alpha,\beta}$-Dihydrowisanidine (**32**)	*P. guineense*	[68]
$\Delta^{\alpha,\beta}$-Dihydrowisanine (**33**)	*P. guineense*	[69, 70]
3,4-Dihydroxy-6-(*N*-ethylamino)benzamide (**34**)	*P. nigrum*	[71]
N-(3,4-Dimethoxybenzoyl)isobutyl-amine (**35**)	*P. amalago*	[62]
N-(3′,4′-Dimethoxycinnamoyl)-isobutylamine (**36**)	*P. amalago*	[62]
N-(3′,4′-Dimethoxycinnamoyl)-Δ^3-piperidin-2-one (**37**)	*P. aborescens*	[72]
N-(3′,5′-Dimethoxycinnamoyl)-pyrrolidine (**38**)	*P. amalago*	[62]
3-(3′,4′-Dimethoxyphenyl)propionamide (**39**)	*P. arboricola*	[73]
(2*E*,4*E*)-*N*-Dodecadienoyl pyrrolidine (**40**)	*P. nigrum*	[19]
(2*E*,4*E*)-*N*-Eicosadienoyl piperidine (**41**)	*P. retrofractum*	[74]
(2*E*,14*E*)-*N*-Eicosadienoyl piperidine (**42**)	*P. retrofractum*	[74]
2,11-Eicosadienoylpyrrolidine (**43**)	*P. amalago*	[62]
3,6-Eicosadienoylpyrrolidine (**44**)	*P. amalago*	[62]
Eicosanoylpyrrolidine (**45**)	*P. amalago*	[62]
2-Eicosenoylpyrrolidine (**46**)	*P. amalago*	[62]
3,4-Epoxy-8,9-dihydropiplartin (**47**)	*P. verrucosum*	[75]
N-cis-Feruloyltyramine (**48**)	*P. argyrophylum*	[25]
N-trans-Feruloyltyramine (**49**)	*P. argyrophylum*	[25]
	P. nigrum	[76]
Filfiline (**50**)	*P. officinarum*	[77]
(*E*)- and (*Z*)-Formouragines (**51**)	*P. argyrophylum*	[25]
(*E*)- and (*Z*)-*N*-Formylnornuciferines (**52**)	*P. argyrophylum*	[25]
N-Formylpiperidine (**53**)	*P. nigrum*	[78]
Futoamide (**54**)	*P. futokadsura*	[52]
	P. hancei	[79]
Guineensine (**55**)	*P. attenuatum*	[80]
	P. brachystachyum	[38]
	P. guineense	[81, 82]
	P. hancei	[50]
	P. longum	[38, 46, 64]
	P. nigrum	[18, 19, 39, 83, 84]
	P. officinarum	[85]
	P. retrofractum	[86]
	P. sylvaticum	[87]

Table 1—*continued.*

Compound	Plant(s)	Reference(s)
3,6-Hexadecadienoylpyrrolidine (**56**)	*P. amalgo*	[62]
Hexadecanoylpyrrolidine (**57**)	*P. amalago*	[62]
2-Hexadecenoylpyrrolidine (**58**)	*P. amalago*	[62]
N-(4-Hydroxyphenyl)ethylene cinnamamide (**59**)	*P. steerni*	[95]
(2*E*,4*E*)-*N*-5-[(4-Hydroxyphenyl)-pentadienoyl]piperidine (**60**)	*P. nigrum*	[76]
2-Hydroxy-1-methoxy-4*H*-dibenzo-(de,g)quinoline-4,5-(6*H*)-dione (**61**)	*P. attenuatum*	[31]
	P. boehimerifolium	[31]
	P. longum	[31, 32]
4-Hydroxy-3-methoxy-*N*-methylpiperolactam (**62**)	*P. ribesioides*	[96]
(2*E*,4*E*)-*N*-Isobutyldecadienamide (**63**)	*P. attenuatum*	[80]
	P. chaba	[57]
	P. guineense	[82, 88]
	P. hancei	[79, 89]
	P. longum	[90]
	P. nepalense	[91]
	P. nigrum	[83]
	P. novae hollandiae	[61]
	P. pedicellosum	[46]
	P. peepuloides	[90]
	P. ribesioides	[92]
	P. sarmentosum	[93]
	P. sylvaticum	[94]
	P. wallichii	[89]
(2*E*,4*E*)-*N*-Isobutyldodecadienamide (**64**)	*P. guineense*	[82]
	P. peepuloides	[97]
(2*E*,4*E*)-*N*-Isobutyleicosadienamide (**65**)	*P. guineense*	[60, 81]
	P. longum	[64]
	P. macropodum	[98]
	P. nigrum	[99]
(2*E*,4*E*,8*Z*)-*N*-Isobutyl-eicosatrienamide (**66**)	*P. longum*	[64]
	P. nigrum	[84]
	P. officinarum	[100]
(2*E*,4*E*,14*E*)-*N*-Isobutyleicosatrienamide (**67**)	*P. retrofractum*	[74]
(2*E*,4*E*)-*N*-Isobutylhexadecadienamide (**68**)	*P. guineense*	[81]
(2*E*,4*E*)-*N*-Isobutyl-7-(3,4-methylenedioxyphenyl)heptadienamide (**69**)	*P. austrosinense*	[101]
	P. falconeri	[11]
(2*E*,4*E*)-*N*-Isobutyloctadecadienamide (**70**)	*P. argyrophylum*	[102]
	P. guineense	[59, 81, 103]
	P. longum	[64]
(2*E*,4*E*,12*E*)-*N*-Isobutyloctadecatrienamide (**71**)	*P. retrofractum*	[74]
(2*E*,4*E*)-*N*-Isobutyloctadienamide (**72**)	*P. banksii*	[104]
	P. nigrum	[84]
	P. novae hollandiae	[61]
Longamide (**73**)	*P. longum*	[38]
1-(*o*-Methoxycinnamoyl)pyrrolidine (**74**)	*P. methysticum*	[105]
6-Methoxypiperoylisobutylamine (**75**)	*P. amalago*	[62]
2′-Methoxy-3′,4′-methylenedioxycinnamoylisobutylamine (**76**)	*P. amalago*	[62]
2′-Methoxy-4′,5′-methylenedioxy-*cis*-cinnamoylpiperidine (**77**)	*P. peepuloides*	[106]
2′-Methoxy-4′,5′-methylenedioxy-*trans*-cinnamoylpiperidine (**78**)	*P. amalago*	[107]
	P. peepuloides	[108]

Table 1—continued.

Compound	Plant(s)	Reference(s)
N-(3′-Methoxy-4′,5′-methylenedioxycinnamoyl)-Δ^3-piperidin-2-one (**79**)	P. aborescens	[72, 109]
N-(3′-Methoxy-4′,5′-methylenedioxydihydrocinnamoyl)-Δ^3-piperidin-2-one (**80**)	P. aborescens	[109]
2′-Methoxy-4′,5′-methylenedioxy-*trans*-cinnamoylpyrrolidine (**81**)	P. amalago P. peepuloides	[107] [110]
2′-Methoxy-3′,4′-methylenedioxycinnamoylpyrrolidine (**82**)	P. amalago	[62]
3′,4′-Methylenedioxycinnamoylisopentylamine (**83**)	P. amalago	[62]
3′,4′-Methylenedioxycinnamoyl-*n*-pentylamine (**84**)	P. amalago	[62]
N-3′,4′-Methylenedioxycinnamoylpiperidine (**85**)	P. novae hollandiae	[61]
3′,4′-Methylenedioxycinnamoylpyrrolidine (**86**)	P. amalago	[62]
17-(3,4-Methylenedioxyphenyl)-16-heptadecenoylpyrrolidine (**87**)	P. amalago	[62]
(2E,8E)-N-9-(3,4-Methylenedioxyphenyl)nonadienoylpiperidine (**88**)	P. longum P. nigrum P. retrofractum	[64] [20] [111]
15-(3,4-Methylenedioxyphenyl)-14-pentadecenoylpyrrolidine (**89**)	P. amalago	[62]
(2E,4E,8E)-N-9-(3,4-Methylenedioxyphenyl)nonatrienoylpyrrolidine (**90**)	P. nigrum	[19]
(2E,4E,10E)-N-11-(3,4-Methylenedioxyphenyl)undecatrienoylpiperidine (**91**)	P. nigrum	[64]
(2E)-4-[(2-Methylpropyl)amino]-4-oxo-butenoic acid (**92**)	P. hancei	[50]
Norcepharadione B (**93**)	P. attenuatum P. boehimerifolium P. hamiltonii P. longum	[31] [31] [31] [31, 32]
1-(2E,4E)-Octadecadienoylpiperidine (**94**)	P. retrofractum	[74]
3,6-Octadecadienoylpyrrolidine (**95**)	P. amalago	[62]
Octadecanoylpyrrolidine (**96**)	P. amalago	[62]
1-(2E,4E,12E)-Octadecatrienoylpiperidine (**97**)	P. retrofractum	[74]
2-Octadecenoylpyrrolidine (**98**)	P. amalago	[62]
9-Octadecenoylpyrrolidine (**99**)	P. amalago	[62]
Peepuloidin (**100**)	P. peepuloides	[110]
N-(3-Phenylpropanoyl)pyrrole (**101**)	P. sarmentosum	[93]
Piperadione (**102**)	P. attenuatum P. hamiltonii P. longum	[31] [31] [31, 32]
Piperamide (**103**)	P. nigrum	[19]
Piperamine (**104**)	P. chaba P. nigrum	[57] [19]
Pipercallosidine (**105**)	P. callosum	[112]
Pipercallosine (**106**)	P. callosum P. interruptum	[112] [113]
Pipereicosalidine (**107**)	P. retrofractum	[74, 111]
Piperettine (**108**)	P. aurantiacum P. nigrum	[114] [19, 23]
1-Piperettylpyrrolidine (**109**)	P. trichostachyon	[115, 116]

Table 1—*continued.*

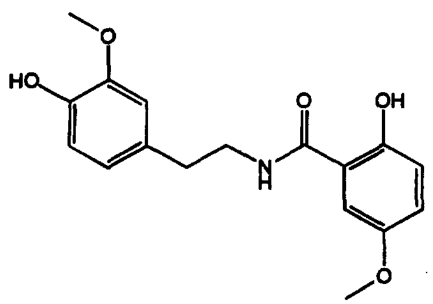
Compound	Plant(s)	Reference(s)
Piperoylisopentylamine (**110**)	*P. amalago*	[62]
Pipericide (**111**)	*P. austrosinense*	[101]
	P. brachystachyum	[38]
	P. guineense	[81, 82]
	P. longum	[64]
	P. nigrum	[17–19, 39, 83, 117, 118]
Piperine (**112**)	*P. acutisleginum*	[41]
	P. album	[119]
	P. argyrophylum	[102]
	P. attenuatum	[80]
	P. aurantiacum	[114]
	P. betle	[41]
	P. callosum	[120]
	P. chaba	[121]
	P. cubeba	[122]
	P. guineense	[59, 60, 81]
	P. hancei	[50]
	P. khasiana	[46]
	P. longum	[64, 123–125]
	P. macropodum	[98]
	P. nepalense	[91]
	P. nigrum	[15, 19, 126, 127]
	P. novae hollandiae	[61]
	P. peepuloides	[97]
	P. retrofractum	[86, 111]
	P. sylvaticum	[87, 128, 129]
Piperine S (**113**)	*P. puberulum*	[130]
Piperlonguminine (**114**)	*P. acutisleginum*	[41]
	P. amalago	[62]
	P. attenuatum	[80]
	P. betle	[41]
	P. chaba	[121]
	P. guineense	[81]
	P. hancei	[50, 79]
	P. khasiana	[46]
	P. longum	[62, 64, 131, 132]
	P. nepalense	[91]
	P. novae hollandiae	[61]
	P. pedicellosum	[46]
	P. sylvaticum	[128]
Pipermethystine (**115**)	*P. methysticum*	[133, 134]
Piperoctadecalidine (**116**)	*P. retrofractum*	[86, 111]
Piperolactam A (**117**)	*P. argyrophylum*	[25]
	P. boehimerifolium	[31]
	P. attenuatum	[31]
	P. hamiltonii	[31]
	P. longum	[31, 32]
	P. wightii	[48]
Piperolactam B (**118**)	*P. acutisleginum*	[12]
	P. argyrophylum	[25]
	P. boehimerifolium	[31]
	P. longum	[31, 32]
Piperolactam C (**119**)	*P. argyrophylum*	[25]
	P. boehimerifolium	[31]
	P. longum	[31]
	P. wightii	[48]

Table 1—*continued.*

Compound	Plant(s)	Reference(s)
Piperolactam D (**120**)	*P. argyrophylum*	[25]
	P. boehimerifolium	[135]
Piperlactam S (**121**)	*P. puberulum*	[130]
Piperolein B (**122**)	*P. nigrum*	[19]
Piperovatine (**123**)	*P. callosum*	[112]
Piplartine/piperlongumine (**124**)	*P. aborescens*	[72]
	P. callosum	[120]
	P. longum	[22, 123–125, 131, 136]
	P. retrofractum	[120]
	P. sylvaticum	[87, 129]
	P. tuberculatum	[137]
Piplartine dimer A (**125**)	*P. aborescens*	[109]
	P. rugosum	[67]
	P. tuberculatum	[122]
(2*E*,4*E*,9*E*,11*Z*)-*N*-Pyrrolidyl-12-(3,4-methylenedioxyphenyl)dodecatetraenamide (**126**)	*P. guineense*	[82]
Retrofractamide A (**127**)	*P. brachystachyum*	[38, 39]
	P. longum	[46]
	P. nigrum	[19]
	P. retrofractum	[138]
	P. ridleyi	[139]
Retrofractamide C (**128**)	*P. retrofractum*	[138]
Retrofractamide D (**129**)	*P. retrofractum*	[138]
Ridleyamide (**130**)	*P. ridleyi*	[139]
Sarmentine (**131**)	*P. nigrum*	[19]
	P. sarmentosum	[93]
Sarmentosine (**132**)	*P. nigrum*	[19]
	P. sarmentosum	[58, 93]
Sylvamide (**133**)	*P. sylvaticum*	[140]
Sylvetin (**134**)	*P. aurantiacum*	[114]
	P. brachystachyum	[141]
	P. chaba	[121]
	P. guineense	[59]
	P. longum	[43]
	P. sylvaticum	[142]
Tembamide acetate (**135**)	*P. guayranum*	[30]
2,4-Tetradecadienoylpyrrolidine (**136**)	*P. amalago*	[62]
Tricholein (**137**)	*P. nigrum*	[19]
	P. trichostachyon	[116]
Trichonine (**138**)	*P. trichostachyon*	[143]
Trichostachine (**139**)	*P. amalago*	[62]
	P. guineense	[81]
	P. macropodum	[98]
	P. nigrum	[19]
	P. trichostachyon	[144]
N-(3′,4′,5′-Trimethoxydihydrocinnamoyl)-Δ^3-piperidin-2-one (**140**)	*P. austrosinense*	[101]
	P. demeraranum	[29]
1,2,3-Trimethoxy-4,5-dioxo-6a,7-dehydroaporphine (**141**)	*P. aborescens*	[72]
3′,4′,5′-Trimethoxycinnamoylisobutylamine (**142**)	*P. amalago*	[62]

Table 1—*continued.*

Compound	Plant(s)	Reference(s)
3′,4′,5′-Trimethoxycinnamoylpyrrolidine (**143**)	*P. amalago*	[62]
Wisanidine (**144**)	*P. amalago* *P. guineense*	[132] [60, 68, 145]
Wisanine (**145**)	*P. guineense*	[60, 69, 70, 146, 147]



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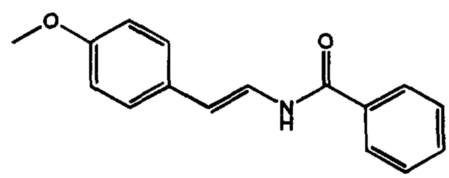

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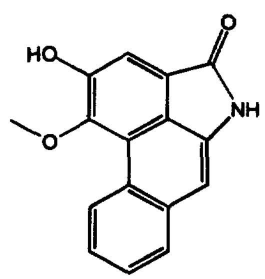

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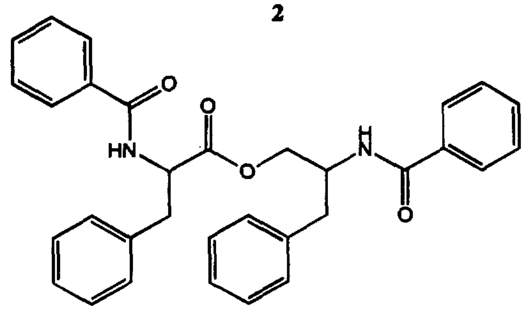

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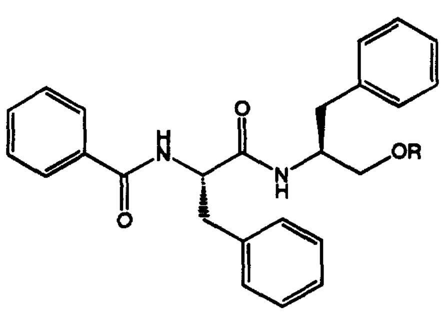
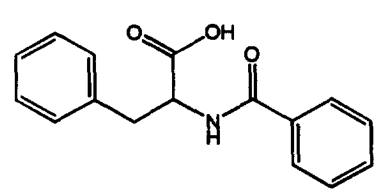


5 R=H
6 R=$COCH_3$
7 R=COPh



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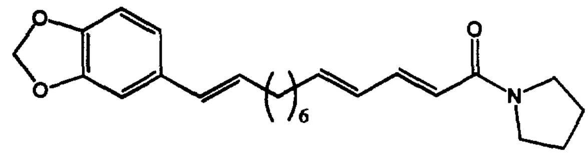

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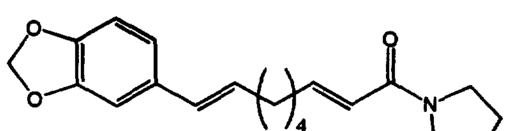

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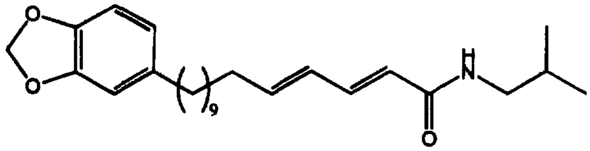

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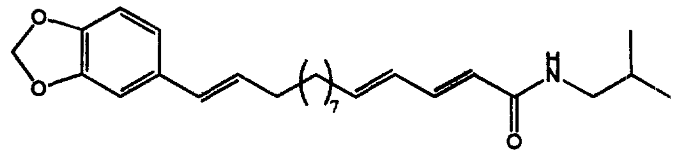

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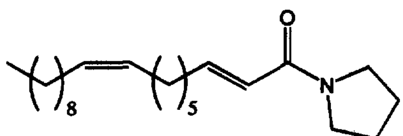

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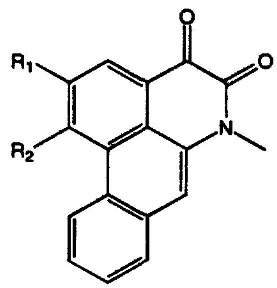
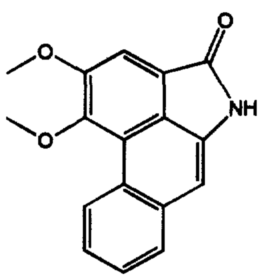


14 $R_1+R_2=OCH_2O$
15 $R_1=R_2=OCH_3$



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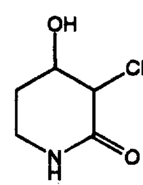

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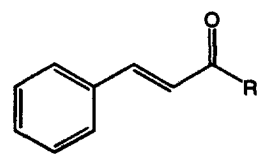
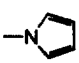
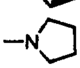
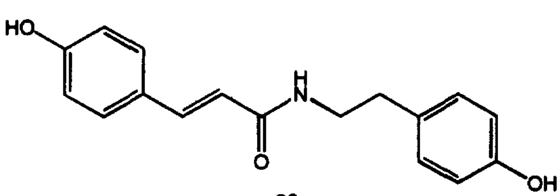


18 R= 

19 R= 



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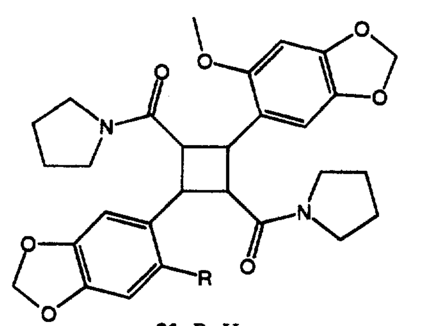
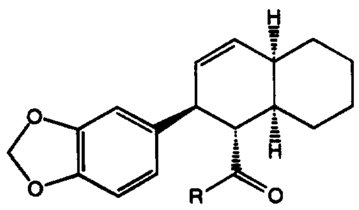
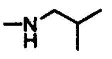
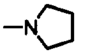
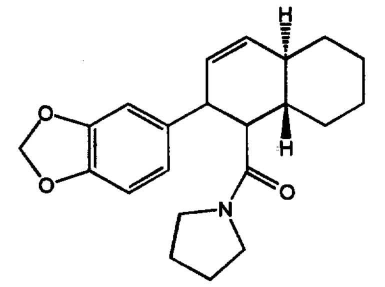


21 R=H
22 $R=OCH_3$



23 R= 

24 R= 



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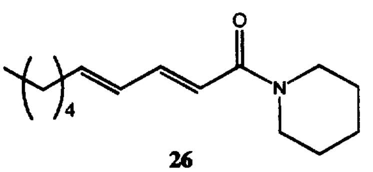

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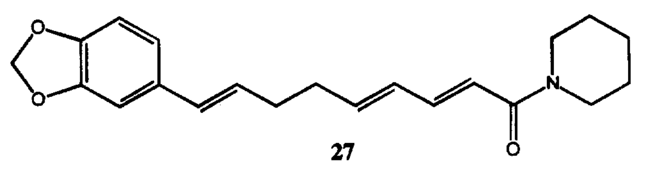

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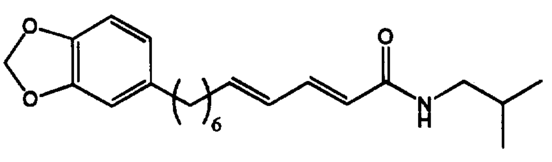

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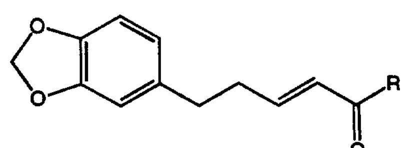
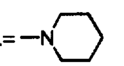
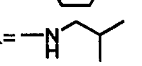
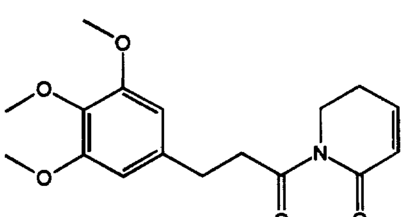


29 R= 

30 R= 



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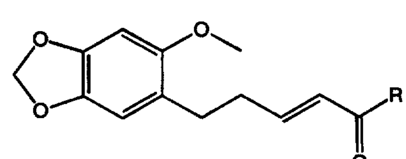
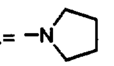
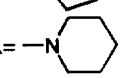
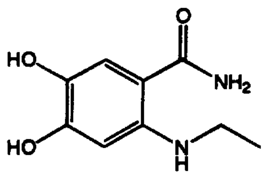


32 R= 

33 R= 



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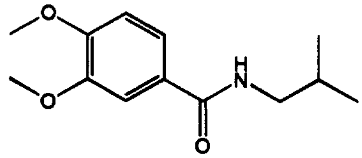

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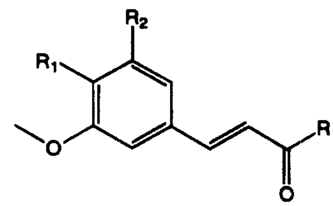
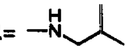
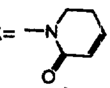
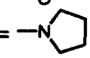
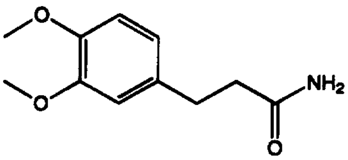


36 R_1=OCH_3; R_2=H; R= 

37 R_1=OCH_3; R_2=H; R= 

38 R_1=H; R_2=OCH_3; R= 



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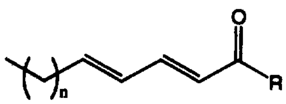
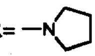
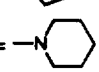
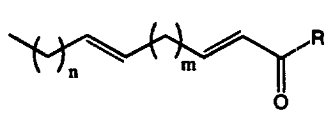
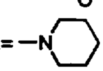
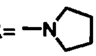


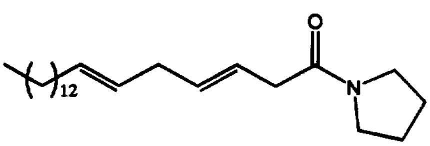
40 n=6; R= 

41 n=14; R= 



42 n=4; m=10; R= 

43 n=m=7; R= 



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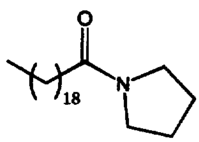

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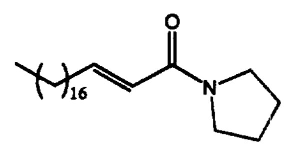

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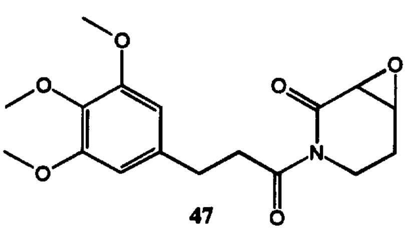

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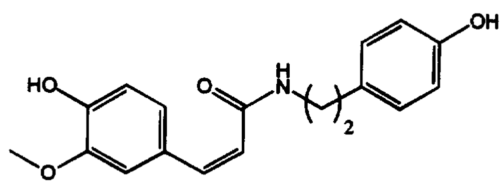

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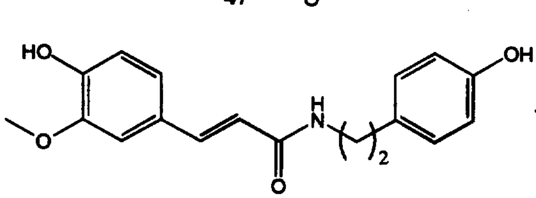

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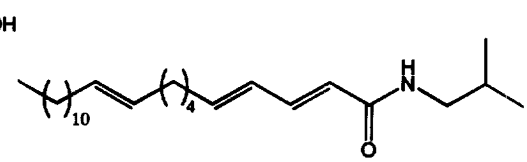

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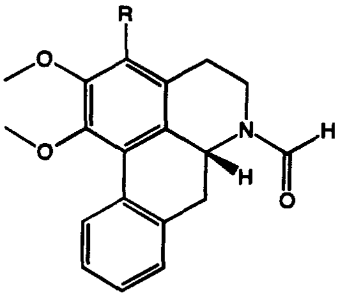
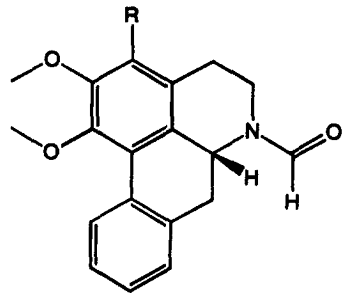
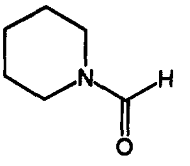


(*Z*)-**51** R=OCH_3
(*Z*)-**52** R=H



(*E*)-**51** R=OCH_3
(*E*)-**52** R=H



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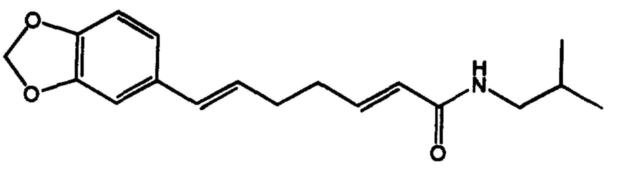

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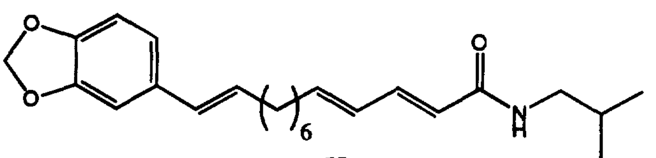

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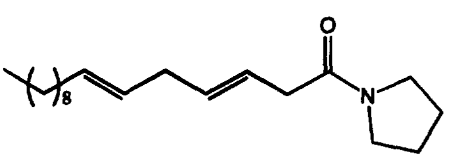

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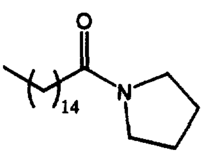

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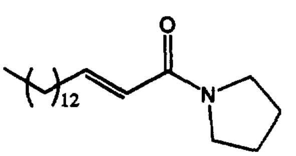

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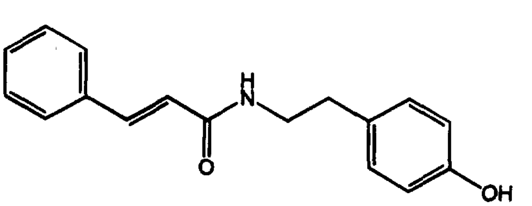

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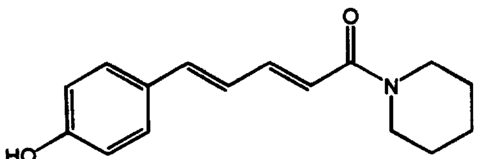

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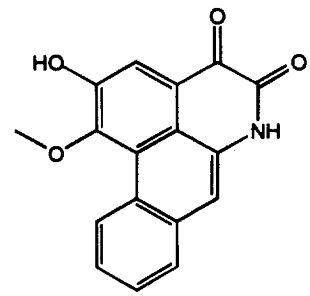

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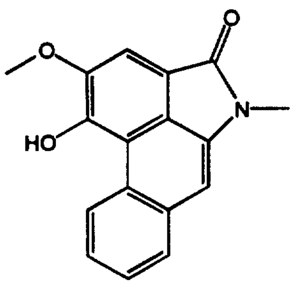

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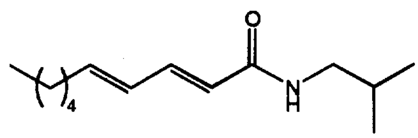

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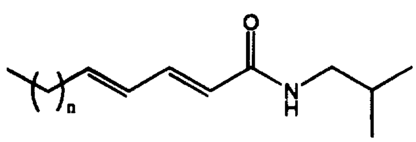
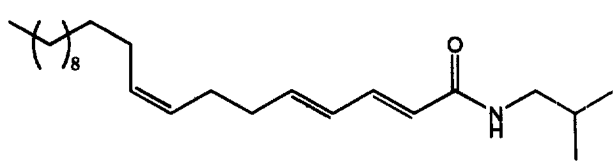


64 n=6
65 n=14
68 n=10
70 n=12
72 n=2



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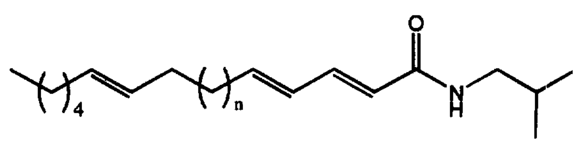
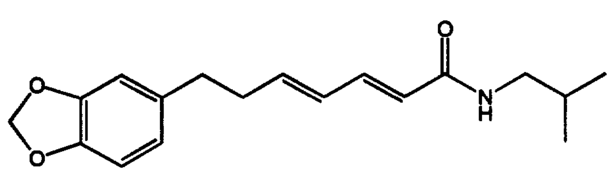


67 n=7
71 n=5



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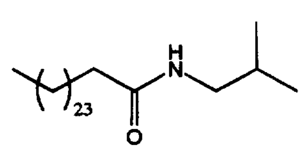

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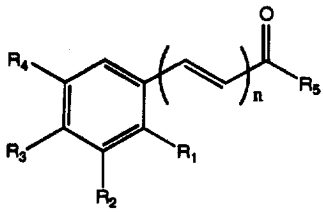
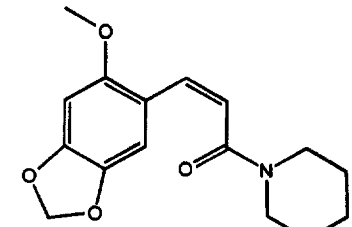
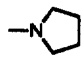
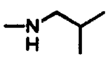
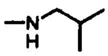


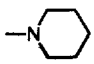


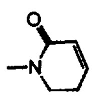
77

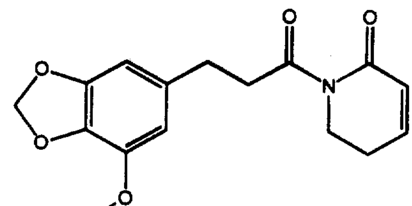
74 n=1; R_1=OCH_3; R_2=R_3=R_4=H; R_5= 

75 n=2; R_1=OCH_3; R_2=H; R_3+R_4=OCH_2O; R_5= 

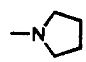
76 n=1; R_1=OCH_3; R_2+R_3=OCH_2O; R_4=H; R_5= 

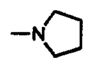
78 n=1; R_1=OCH_3; R_2=H; R_3+R_4=OCH_2O; R_5= 

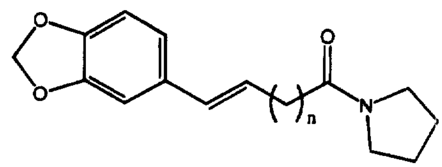
79 n=1; R_1=H; R_2+R_3=OCH_2O; R_4=OCH_3; R_5= 



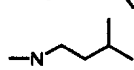
80

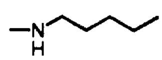
81 n=1; R_1=OCH_3; R_2=H; R_3+R_4=OCH_2O; R_5= 

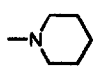
82 n=1; R_1=OCH_3; R_2+R_3=OCH_2O; R_4=H; R_5= 

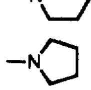


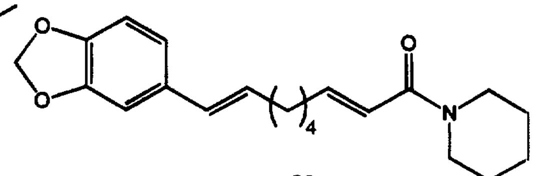
87 n=14
89 n=12

83 n=1; R_1=R_2=H; R_3+R_4=OCH_2O; R_5= 

84 n=1; R_1=R_2=H; R_3+R_4=OCH_2O; R_5= 

85 n=1; R_1=R_2=H; R_3+R_4=OCH_2O; R_5= 

86 n=1; R_1=R_2=H; R_3+R_4=OCH_2O; R_5= 



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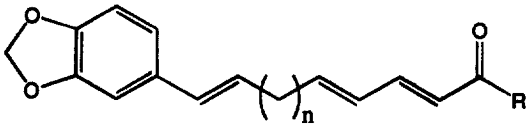
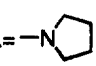
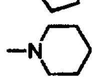
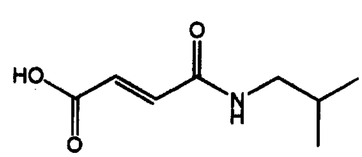


90 n=2; R= 

91 n=4; R= 



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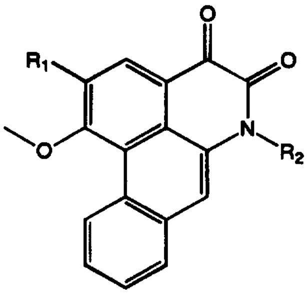
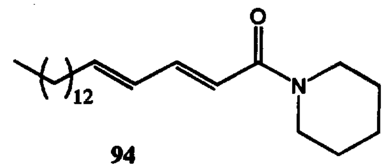


93 R_1=OCH_3; R_2=H
102 R_1=OH; R_2=CH_3



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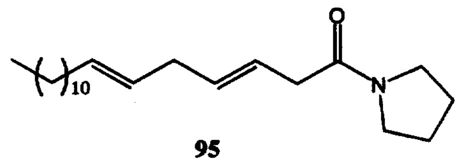

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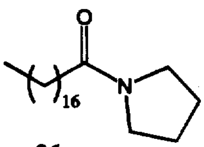

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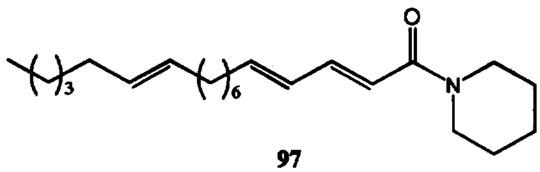

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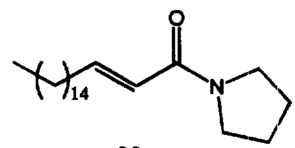

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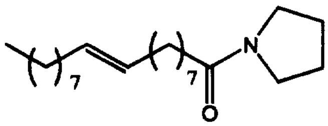

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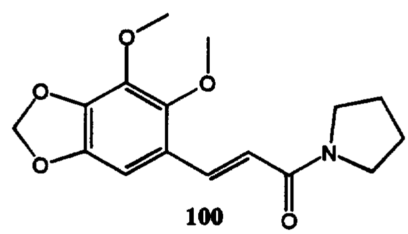

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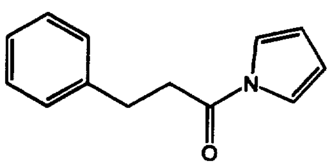

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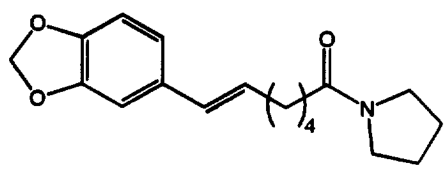

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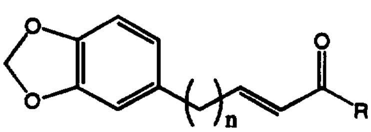
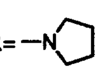
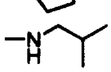
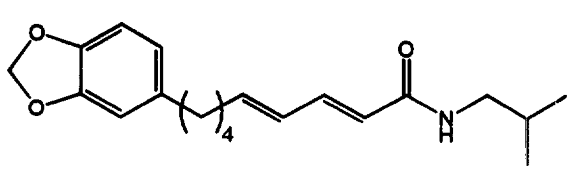


104 n=2; R= 

105 n=4; R= 



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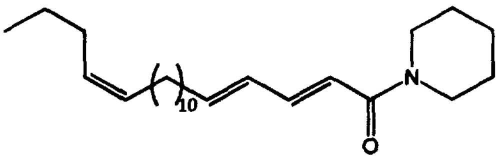

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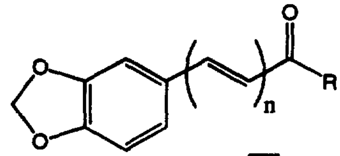
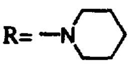
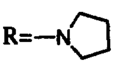
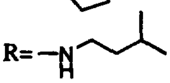
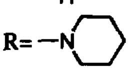


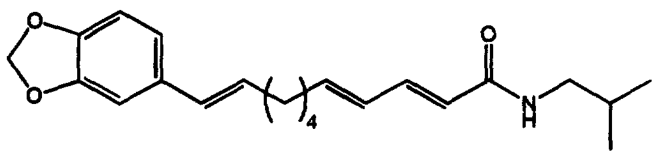
108 n=3; R= 

109 n=3; R= 

110 n=2; R= 

112 n=2; R= 

114 n=2; R= 



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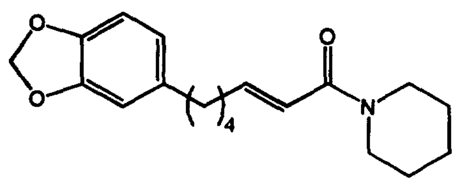

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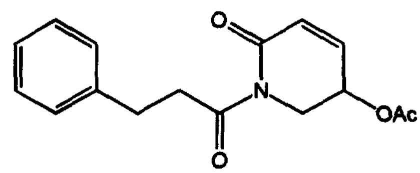

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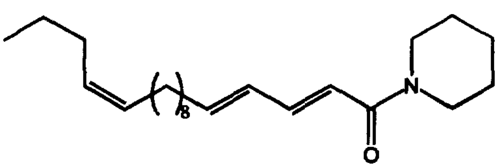

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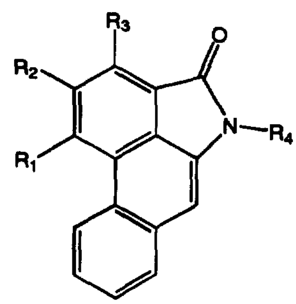
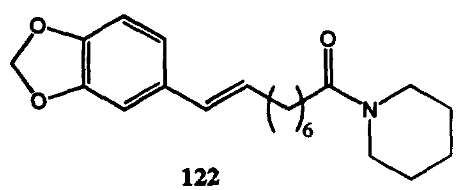


117 R_1=OH; R_2=OCH_3; R_3=R_4=H
118 R_1=R_2=OCH_3; R_3=OH; R_4=H
119 R_1=R_2=R_3=OCH_3; R_4=H
120 R_1=OH; R_2=R_3=OCH_3; R_4=H
121 R_1=OCH_3; R_2=OH; R_3=H; R_4=CH_3



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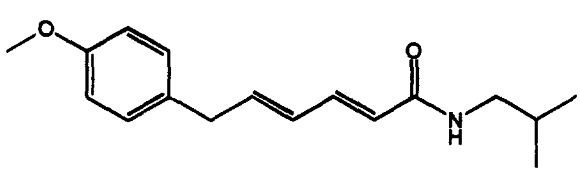

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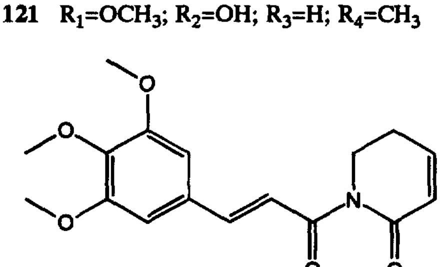
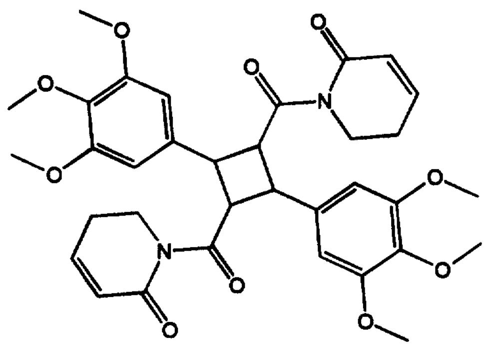


124



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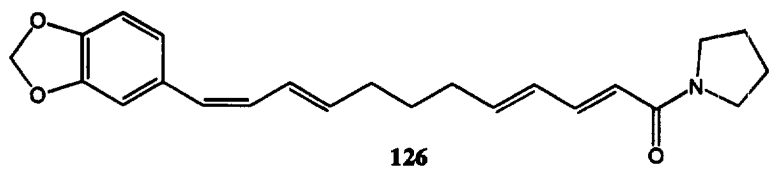
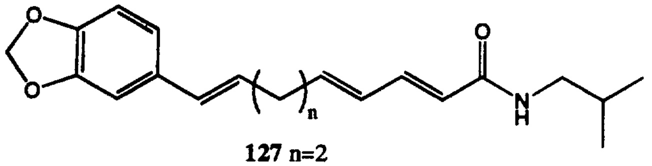
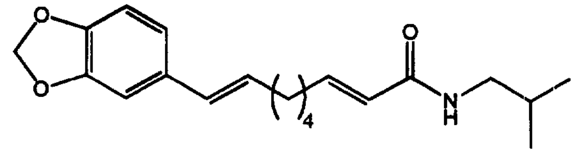


126



127 n=2
129 n=3



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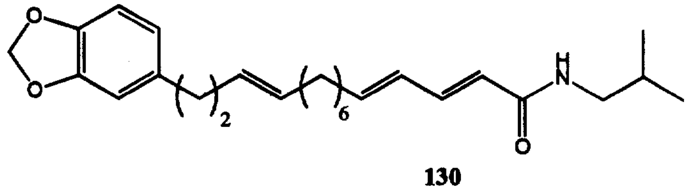

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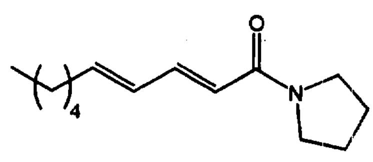

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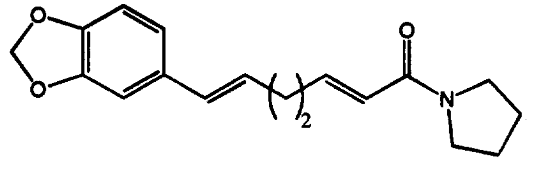

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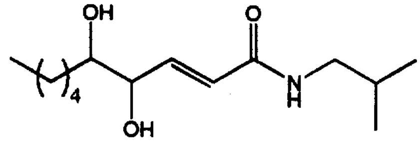

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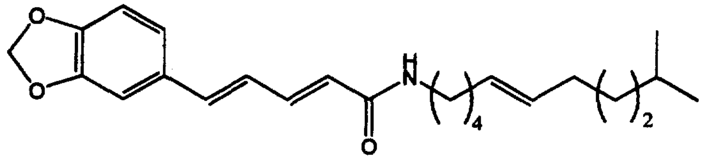

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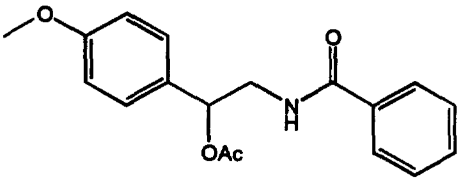

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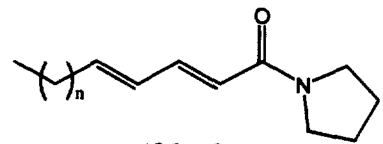
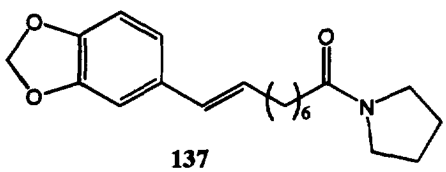


136 n=8
138 n=14



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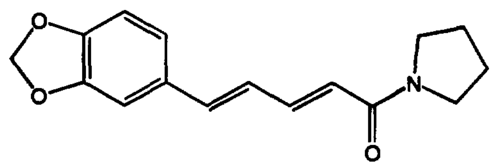

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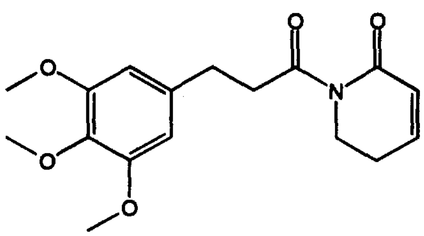

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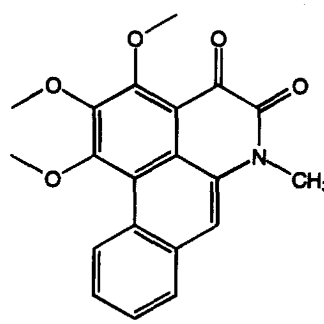

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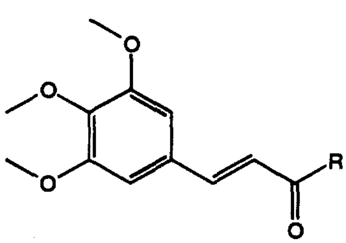
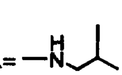
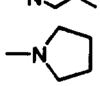
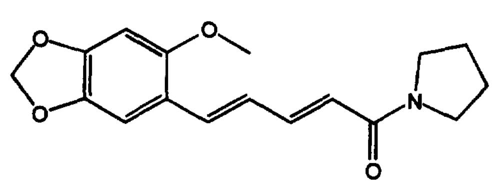


142 R= 

143 R= 



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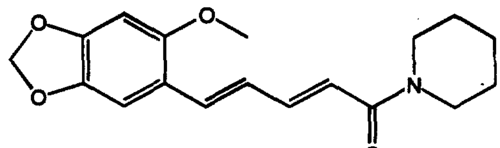

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PROPENYLPHENOLS

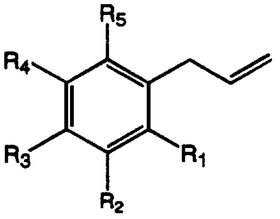
Five propenylphenols (**147**, **153–155** and **163**) with significant fungicidal and nematicidal activity were isolated from the chloroform extract of the leaves of *P. betle* [148]. Eugenol (**161**) isolated from *P. betle* exhibited antifungal activity against *Aspergillus flavus* [149] and pseudodillapiole (**171**) has been reported to show strong antimicrobial activity [150]. Recently, Masuda *et al.* have isolated four propenylphenols (**146** and **150–152**) from *P. sarmentosum* [151], all these compounds have been reported to show inhibitory activities against *E. coli* and *Bacillus subtilis*. Dillapiole (**156**) isolated from *P. aduncum* [152] has shown molluscicidal activity against *Biomphalaria glabrata*. Various propenylphenols isolated so far from different *Piper* species are listed in Table 2.

Table 2. Propenylphenols from *Piper* species

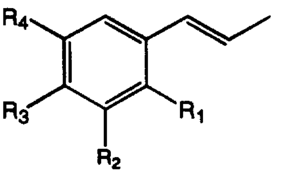
Compound	Plant(s)	Reference(s)
1-Allyl-2,6-dimethoxy-3,4-methylenedioxybenzene (**146**)	*P. sarmentosum*	[151]
Allylpyrocatechol diacetate (**147**)	*P. betle*	[148, 153]
Anethole (**148**)	*P. marginatum*	[154]
Apiole (**149**)	*P. argyrophylum*	[51]
	P. brachystachyum	[46, 155]
	P. schmidtii	[156]
Asaricin (**150**)	*P. aduncum*	[46, 157]
	P. sarmentosum	[151]
α-Asarone (**151**)	*P. sarmentosum*	[151, 158]
	P. sumatranum	[159, 160]
γ-Asarone (**152**)	*P. divaricatum*	[161]
	P. sarmentosum	[151]
Chavibetol (**153**)	*P. betle*	[148, 153]
Chavibetol acetate (**154**)	*P. betle*	[148, 153]
Chavicol (**155**)	*P. betle*	[148, 162]
Dillapiole (**156**)	*P. aduncum*	[46, 65, 152, 163]
	P. banksii	[104]
	P. guineense	[164]
	P. novae hollandiae	[61]
	P. marginatum	[165]
1,3-Dimethoxy-2-acetoxy-5-allylbenzene (**157**)	*P. aduncum*	[46]
2,6-Dimethoxy-4-allylphenol (**158**)	*P. aduncum*	[46]
Elemicin (**159**)	*P. aduncum*	[46]
	P. auritum	[166]
	P. banksii	[104]
	P. guineense	[164]
	P. lenticellosum	[167]
	P. marginatum	[165]
Estragole (**160**)	*P. marginatum*	[165]
Eugenol (**161**)	*P. auritum*	[166]
	P. betle	[149, 153, 168]
	P. cavalcantei	[169]
	P. guineense	[164]
	P. nigrum	[154]
	P. sylvestre	[170]
Eugenol methyl ether (**162**)	*P. betle*	[153, 168]
	P. cavalcantei	[169]
	P. guineense	[164]
	P. hispidinervium	[171]
	P. lenticellosum	[167]
	P. marginatum	[165, 172]
	P. nigrum	[154]

Table 2—*continued.*

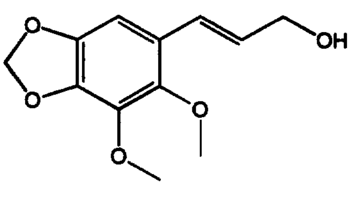
Compound	Plant(s)	Reference(s)
Hydroxychavicol (**163**)	*P. betle*	[148, 168, 173]
4-Hydroxy-2,5-dimethoxyallylbenzene (**164**)	*P. divaricatum*	[161]
ω-Hydroxyisodillapiole (**165**)	*P. novae hollandiae*	[174]
Isoelemicin (**166**)	*P. guineense*	[164]
	P. marginatum	[165]
Isoeugenol (**167**)	*P. betle*	[168]
Isoeugenol methyl ether (**168**)	*P. marginatum*	[165]
Isosafrole (**169**)	*P. lenticellosum*	[167]
Myristicine (**170**)	*P. aduncum*	[46, 152, 175, 176]
	P. auritum	[166]
	P. guineense	[164]
	P. marginatum	[165]
	P. nigrum	[177]
Pseudodillapiole (**171**)	*P. aduncum*	[150, 162, 167, 178–180]
	P. fadyenii	[179]
	P. hispidum	[150, 178–180]
Safrole (**172**)	*P. aduncum*	[46]
	P. auritum	[166]
	P. betle	[168]
	P. callosum	[171, 181]
	P. cavalcantei	[169]
	P. guineense	[164]
	P. hispidinervium	[150, 171]
	P. marginatum	[165, 182, 183]
	P. nigrum	[177]
	P. sylvestre	[170]
Sarisan (**173**)	*P. guineense*	[164]
	P. lenticellosum	[167]



146 R_1=R_5=OCH_3; R_2+R_3=OCH_2O; R_4=H
147 R_1=R_4=R_5=H; R_2=R_3=OAc
149 R_1=R_4=OCH_3; R_2+R_3=OCH_2O; R_5=H
150 R_1=OCH_3; R_2=R_5=H; R_3+R_4=OCH_2O
152 R_1=R_3=R_4=OCH_3; R_2=R_5=H
153 R_1=R_4=R_5=H; R_2=OH; R_3=OCH_3
154 R_1=R_4=R_5=H; R_2=OAc; R_3=OCH_3
155 R_1=R_2=R_4=R_5=H; R_3=OH
156 R_1=R_2=OCH_3; R_3+R_4=OCH_2O; R_5=H
157 R_1=R_5=H; R_2=R_4=OCH_3; R_3=OAc
158 R_1=R_5=H; R_2=R_4=OCH_3; R_3=OH
159 R_1=R_5=H; R_2=R_3=R_4=OCH_3
160 R_1= R_2=R_4=R_5=H; R_3=OCH_3
161 R_1=R_4=R_5=H; R_2=OCH_3; R_3=OH
162 R_1=R_4=R_5=H; R_2=R_3=OCH_3
163 R_1=R_4=R_5=H; R_2=R_3=OH
164 R_1=R_4=OCH_3; R_2=R_5=H; R_3=OH
170 R_1=R_5=H; R_2=OCH_3; R_3+R_4=OCH_2O
171 R_1+R_2=OCH_2O; R_3=R_4=OCH_3; R_5=H
172 R_1=R_4=R_5=H; R_2+R_3=OCH_2O



148 R_1=R_2=R_4=H; R_3=OCH_3
151 R_1=R_3=R_4=OCH_3; R_2=H
166 R_1=H; R_2=R_3=R_4=OCH_3
167 R_1=R_2=H; R_3=OH; R_4=OCH_3
168 R_1=R_2=H; R_3=R_4=OCH_3
169 R_1=R_2=H; R_3+R_4=OCH_2O
173 R_1=OCH_3; R_2=H; R_3+R_4=OCH_2O



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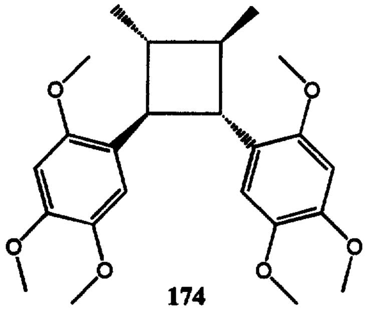

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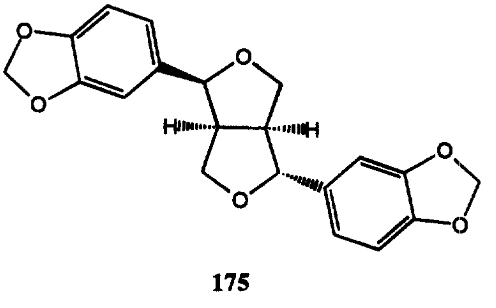

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LIGNANS

Lignans form a family of optically active plant products. They are composed of two C_6, C_3 units linked at the β-carbons of the side chain. They possess a breadth of biological activities [184]. Several lignans have been isolated from different *Piper* species (Table 3). Sesamin (**212**) was the first lignan to be isolated from *P. peepuloides* [97].

Table 3. Lignans from *Piper* species

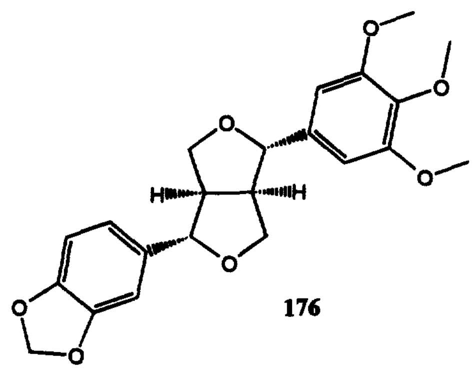
Compound	Plant(s)	Reference(s)
Andamanicin (**174**)	*P. sumatranum*	[159]
(+)-Asarinine (**175**)	*P. brachystachyum*	[38, 141]
	P. longum	[38, 39, 46]
	P. sumatranum	[159]
Aschantin (**176**)	*P. cubeba*	[185]
	P. guineense	[185, 186]
(2*R*,3*R*)-[2-(1,3-Benzodioxol-5-yl)methyl-3-(3,4,5-trimethoxyphenylmethyl]-butan-1,4-diol (**177**)	*P. clusii*	[187]
(+)-Calopiptin (**178**)	*P. schmidtii*	[156]
	P. wightii	[188]
(−)-Clusin (**179**)	*P. clusii*	[189]
	P. cubeba	[190]
(−)-Cubebin (**180**)	*P. clusii*	[189]
	P. cubeba	[190]
	P. cuneifolium	[194]
	P. lacunosum	[191]
	P. nigrum	[192]
	P. ribesioides	[92]
	P. trichostachyon	[193]
(−)-Cubebinin (**181**)	*P. clusii*	[160]
	P. cubeba	[190]
(−)-Cubebininolide (**182**)	*P. clusii*	[187]
	P. cubeba	[195]
(−)-Cubebinone (**183**)	*P. cubeba*	[195]
(+)-Diaeudesmin (**184**)	*P. longum*	[43]
	P. peepuloides	[46, 196]
	P. sylvaticum	[197]
(+)-Diayangambin (**185**)	*P. aborescens*	[72]
(−)-Dihydroclusin (**186**)	*P. cubeba*	[190]
(−)-Dihydrocubebin (**187**)	*P. clusii*	[189]
	P. cubeba	[190]
	P. guineense	[81, 198]
	P. trichostachyon	[193]
(−)-Dihydrotrichostin (**188**)	*P. trichostachyon*	[193]
(−)-3,4-Dimethoxy-3,4-desmethylenedioxycubebin (**189**)	*P. nigrum*	[192]
(−)-3′,4′-Dimethoxy-3′,4′-desmethylenedioxycubebin (**190**)	*P. nigrum*	[192]
rel-(7*S*,8*S*,7′*S*,8′*S*)-3′,4′-Dimethoxy-3,4-methylenedioxy-7.O.7′,8.8′-lignan (**191**)	*P. wightii*	[199]
(2*S*,3*R*,4*S*,5*S*)-Diveratryldimethyltetrahydrofuran (**192**)	*P. clarkii*	[200]
(+)-*epi*-Excelsin (**193**)	*P. aborescens*	[72]
(2*S*,3*R*,4*R*)-[2-Ethoxy-3-(3,4,5-trimethoxyphenyl)methyl-4-(1,3-benzodioxol-5-yl)methyl]tetrahydrofuranol (**194**)	*P. clusii*	[187]
α-*O*-Ethylcubebin (**195**)	*P. clusii*	[160]
	P. cubeba	[201]

Table 3—*continued.*

Compound	Plant(s)	Reference(s)
β-O-Ethylcubebin (**196**)	*P. cubeba*	[201]
Fargesin (**197**)	*P. austrosinense*	[101]
	P. brachystachyum	[38, 39]
	P. longum	[38, 39]
Galgravin (**198**)	*P. futokadsura*	[202]
	P. hancei	[89]
	P. puberculum	[203]
	P. wallichii	[89]
(+)-Galbelgin (**199**)	*P. attenuatum*	[204, 205]
	P. futokadsura	[202]
	P. thomsoni	[46]
	P. wightii	[188]
(+)-Grandisin (**200**)	*P. polysyphorum*	[206]
Hemiariensin (**201**)	*P. cubeba*	[201]
Heterotropan (**202**)	*P. cubeba*	[201]
(−)-Hinokinin (**203**)	*P. clusii*	[160, 189]
	P. cubeba	[170]
	P. ribesioides	[92]
	P. trichostachyon	[193]
(−)-Isoyatein (**204**)	*P. cubeba*	[195]
Kusunokinin (**205**)	*P. chaba*	[57]
(−)-Machilin G (**206**)	*P. schmidtii*	[156]
	P. wightii	[188]
Magnosalin (**207**)	*P. cubeba*	[201]
(2*R*,3*R*)[2-(7-Methoxy-1,3-benzodioxol-5-yl)methyl-3-(3,4,5-trimethoxyphenyl)methyl]butan-1,4-diol (**208**)	*P. clusii*	[187]
(−)-5″-Methoxyhinokinin (**209**)	*P. cubeba*	[201]
	P. trichostachyon	[193]
(2*R*,3*R*)-2-(3″,4″-Methylenedioxybenzyl)-3-(3′,4′-dimethoxybenzyl)butyrolactone (**210**)	*P. cubeba*	[195]
Pluviatilol (**211**)	*P. brachystachyum*	[38]
	P. longum	[38]
Sesamin (**212**)	*P. austrosinense*	[101]
	P. brachystachyum	[38, 46, 141]
	P. clusii	[185]
	P. cubeba	[185]
	P. guineense	[81]
	P. longum	[38, 43, 125, 207]
	P. lowong	[208]
	P. peepuloides	[97]
	P. sylvaticum	[129]
	P. retrofractum	[138]
(+)-Sylvatesmin (**213**)	*P. sylvaticum*	[209]
(+)-Sylvone (**214**)	*P. sylvaticum*	[210]
(−)-Thujaplicatin trimethylether (**215**)	*P. cubeba*	[195]
(−)-Trichostin (**216**)	*P. trichostachyon*	[193]
(+)-Veraguensin (**217**)	*P. cuneifolium*	[194]
	P. futokadsura	[202]
	P. puberculum	[203]

Table 3—*continued.*

Compound	Plant(s)	Reference(s)
(+)-Yangambin (**218**)	*P. guineense*	[186]
(−)-Yatein I (**219**)	*P. clusii* *P. cubeba*	[189] [195]
(−)-Zuonin A (**220**)	*P. schmidtii*	[156]



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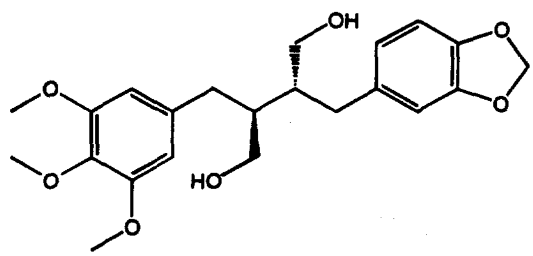

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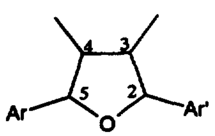
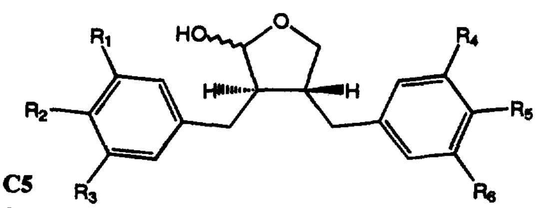
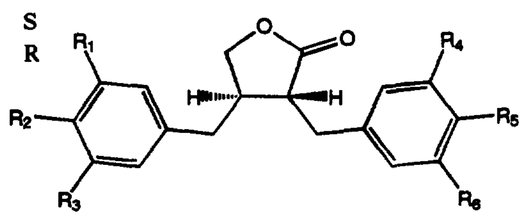


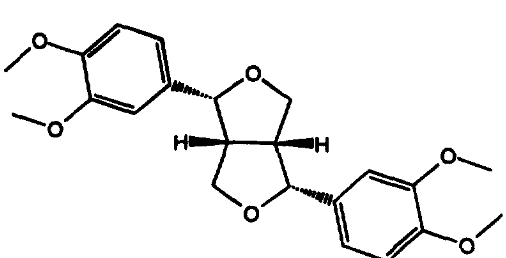
	Ar	Ar'	C2	C3	C4	C5
178	Piperonyl	Veratryl	R	S	S	S
191	Piperonyl	Veratryl	S	S	S	S
192	Veratryl	Veratryl	S	R	S	S
198	Veratryl	Veratryl	R	R	S	S
199	Veratryl	Veratryl	R	R	R	R
200	3,4,5-Trimethoxyphenyl	3,4,5-Trimethoxyphenyl	S	S	S	S
206	Piperonyl	Veratryl	R	R	S	S
217	Veratryl	Veratryl	R	S	S	S
220	Piperonyl	Piperonyl	R	R	S	R



179 $R_1=R_2=R_3=OCH_3$; $R_4+R_5=OCH_2O$; $R_6=H$
180 $R_1+R_2=R_4+R_5=OCH_2O$; $R_3=R_6=H$
181 $R_1=R_2=R_3=R_4=R_5=R_6=OCH_3$
189 $R_1=R_2=OCH_3$; $R_3=R_6=H$; $R_4+R_5=OCH_2O$
190 $R_1+R_2=OCH_2O$; $R_3=R_6=H$; $R_4=R_5=OCH_3$



182 $R_1=R_2=R_3=R_4=R_5=R_6=OCH_3$
183 $R_1=R_2=R_3=R_6=OCH_3$; $R_4+R_5=OCH_2O$
203 $R_1+R_2=R_4+R_5=OCH_2O$; $R_3=R_6=H$
204 $R_1=R_2=R_3=OCH_3$; $R_4+R_5=OCH_2O$; $R_6=H$
205 $R_1+R_2=OCH_2O$; $R_3=R_6=H$; $R_4=R_5=OCH_3$
209 $R_1+R_2=R_4+R_5=OCH_2O$; $R_3=H$; $R_6=OCH_3$
210 $R_1=R_2=OCH_3$; $R_3=R_6=H$; $R_4+R_5=OCH_2O$
215 $R_1=R_2=R_4=R_5=R_6=OCH_3$; $R_3=H$
219 $R_1+R_2=OCH_2O$; $R_3=H$; $R_4=R_5=R_6=OCH_3$



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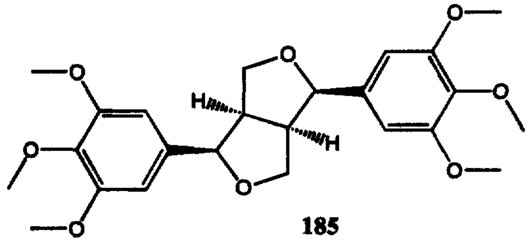

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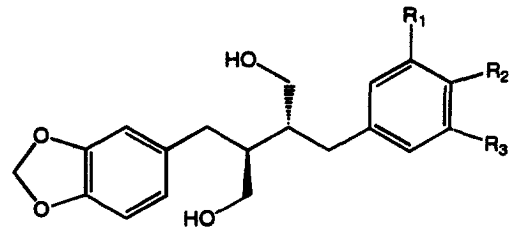
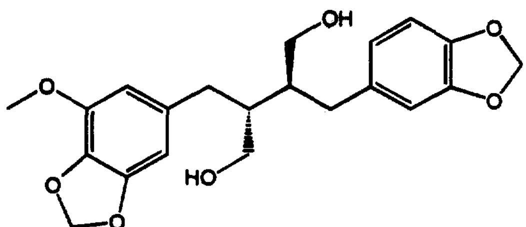


186 $R_1=R_2=R_3=OCH_3$
187 $R_1+R_2=OCH_2O$; $R_3=H$



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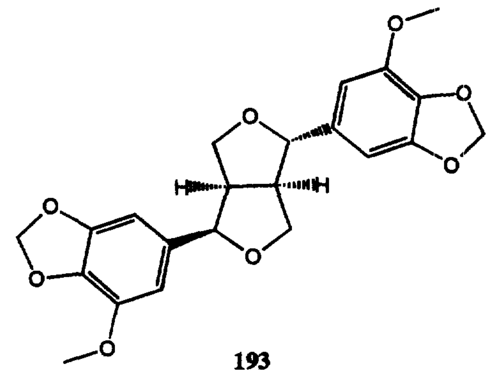

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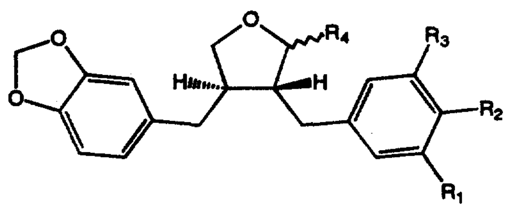
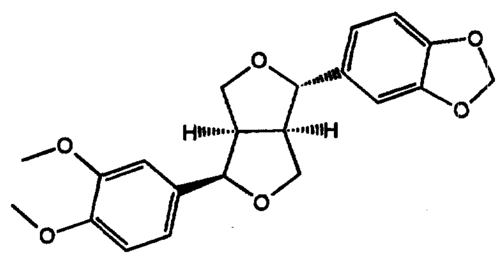


194 $R_1=R_2=R_3=OCH_3$; $R_4=OC_2H_5$
195 $R_1+R_2=OCH_2O$; $R_3=H$; $R_4=\alpha\text{-}OC_2H_5$
196 $R_1+R_2=OCH_2O$; $R_3=H$; $R_4=\beta\text{-}OC_2H_5$



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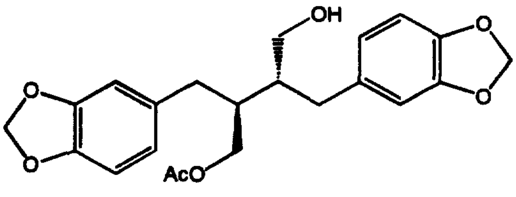

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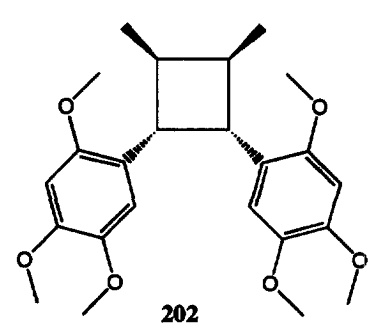

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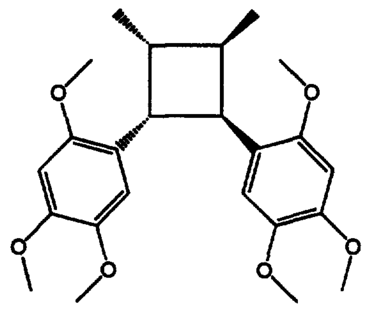

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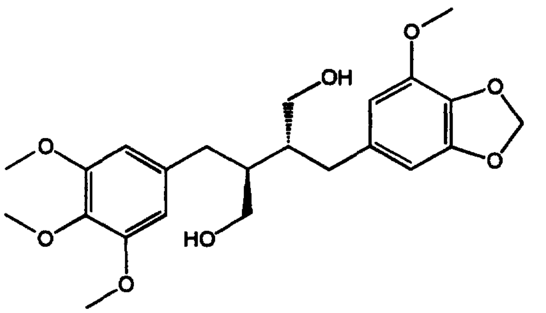

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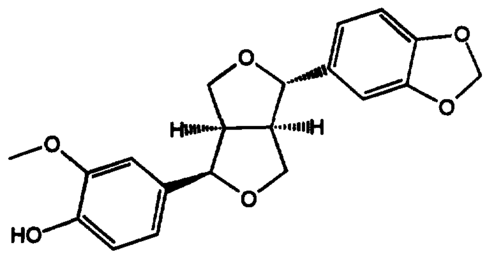

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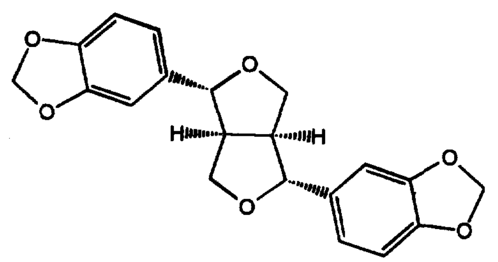

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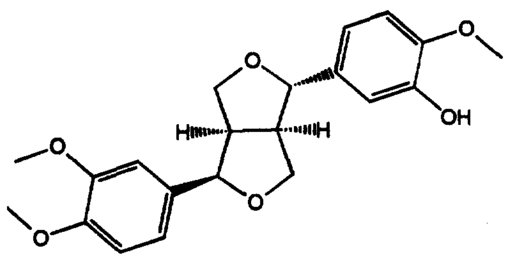

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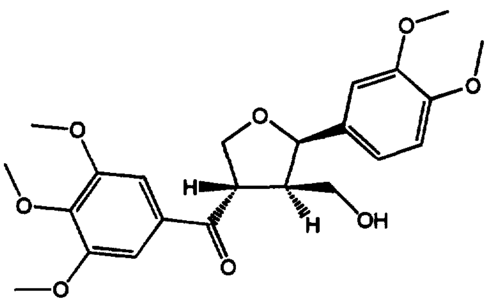

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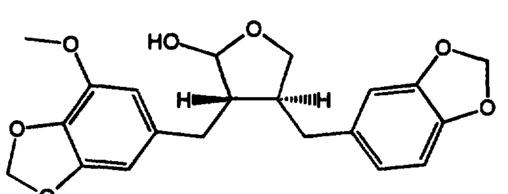

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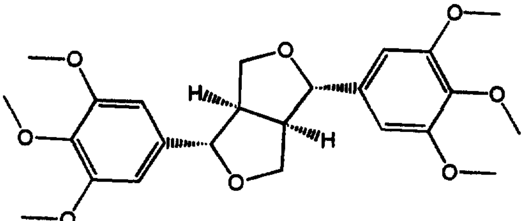

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NEOLIGNANS

Chang *et al.* [211, 212] isolated three neolignans (**268**–**270**) from *P. futokadsura* and reported that kadsurenone (**268**) was the most effective in inhibiting the binding of platelet activity to a receptor site on isolated rabbit platelet plasma membranes. It potentially inhibits PAF-induced degranulation of human neutrophils at 2.5–5.0 μM, without any agonist activity. It is active when administered orally at 25–50 mg kg^{-1} in blocking PAF-induced cutaneous permeability in the guinea pig. It also inhibits the increase of plasma lysosomal enzymes and hematocrit induced by PAF in the rat. Ma *et al.* [213] isolated kadsurenins K and L (**266** and **267**) from *P. kadsura* and reported their significant PAF antagonist activity. Recently, it has been reported by us [53] that the compound isolated by Joshi *et al.* [214] from *P. schmidtii*, named as schmiditin (**282**) is nothing else but the earlier reported kadsurin B (**270**), and it was proposed to eliminate the name schmiditin and the corresponding structure from the literature. Recently, Zhang *et al.* have isolated three new neolignans, namely puberulins A, B and C (**279–281**) from the stems of *P. puberulum* [215]. Puberulins A and C (**279** and **281**) inhibited specific platelet activating factor receptor binding with IC_{50} values of 7.3 and 5.7 μM, respectively. The neolignans isolated from different *Piper* species have been included in Table 4.

Table 4. Neolignans from *Piper* species

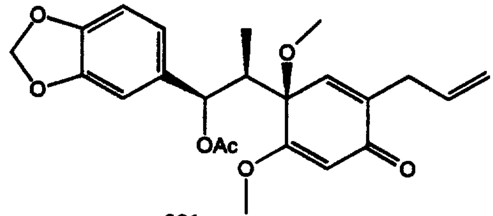
Compound	Plant(s)	Reference(s)
(7*R*,8*R*,3′*R*)-7-Acetoxy-3′,4′-dimethoxy-3,4-methylenedioxy-6′-oxo-$\Delta^{1',4',8'}$-8.3′-lignan (**221**)	*P. wightii*	[188]
(7*R*,8*R*,3′*R*)-7-Acetoxy-3,3′,4,4′-tetramethoxy-6′-oxo-$\Delta^{1',4',8'}$-8.3′-lignan (**222**)	*P. wightii*	[48]
2′-Acetoxy-4′-oxo-3,4,5′-trimethoxy-$\Delta^{5',8'}$-8.3′,7.4′-lignan (**223**)	*P. kadsura*	[216]
4-[2-(1,3-Benzodioxol-5-yl)-2-hydroxy-1-methylethyl]-2,5-dimethoxy-2-(2-propenyl)-3,5-cyclohexadiene-1-one (**224**)	*P. argyrophylum*	[25]
rel-(7*S*,8*S*)-$\Delta^{8'}$-3,4,3′,4′-Bis-methylene-dioxy-7.O.2′,8.3′-lignan (**225**)	*P. capense*	[217]
(+)-Burchellin (**226**)	*P. puberculum*	[203]
	P. wightii	[218]
Clarkinol (**227**)	*P. clarkii*	[219]
Conocarpan (**228**)	*P. decurrens*	[65, 220]
Cuneifolin (**229**)	*P. cuneifolium*	[194]
Denudatin B (**230**)	*P. clarkii*	[200]
	P. hancei	[89, 221]
	P. wallichii	[89]
$\Delta^{8'}$-1′,2′-Dihydro-3,4,3′,4′-bis-methylenedioxy-2′-oxo-8.1′-lignan (**231**)	*P. capense*	[222]
iso-$\Delta^{8'}$-1′,2′-Dihydro-3,4,3′,4′-bis-methylenedioxy-2′-oxo-8.1′-lignan (**232**)	*P. capense*	[222]
$\Delta^{8'}$-3′,6′-Dihydro-3,4,3′,4′-bis-methylenedioxy-6′-oxo-8.3′-lignan (**233**)	*P. capense*	[222]
$\Delta^{8'}$-1′,2′-Dihydro-4-hydroxy-3-methoxy-3′,4′-methylenedioxy-2′-oxo-8.1′-lignan (**234**)	*P. capense*	[222]
(7*R*,8*S*,1′*S*)-$\Delta^{8'}$-1′,4′-Dihydro-5′-methoxy-3,4-methylenedioxy-4′-oxo-8.1′,7.O.2′-lignan (**235**)	*P. argyrophylum*	[25]
	P. clarkii	[219]
	P. kadsura	[234]
	P. schmidtii	[53]
	P. wightii	[218]
(7*R*,8*S*,3′*S*)-$\Delta^{8'}$-3′,6′-Dihydro-3′-methoxy-3,4-methylenedioxy-6′-oxo-8.3′,7.O.4′-lignan (**236**)	*P. wightii*	[218]
(7*R*,8*S*,1′*S*)-$\Delta^{8'}$-1′,4′-Dihydro-3,4,5′-trimethoxy-4′-oxo-$\Delta^{2'}$,5′,8′-8.1′,7.O.2′-lignan (**237**)	*P. schmidtii*	[53]
	P. wightii	[48]
(7*R*,8*R*,1′*S*)-$\Delta^{8'}$-1′,6′-Dihydro-1′,3,4-trimethoxy-6′-oxo-7.O.4′,8.3′-lignan (**238**)	*P. clarkii*	[219]
1′,2′-Dimethoxy-3,4-methylenedioxy-4′-oxo-$\Delta^{2',5',8'}$-8.5′-lignan (**239**)	*P. wightii*	[19]
4′,5′-Dimethoxy-3,4-methylenedioxy-2′-oxo-$\Delta^{3',5',8'}$-8.1-lignan (**240**)	*P. argyrophylum*	[25]
	P. wightii	[199]
iso-4′,5′-Dimethoxy-3,4-methylenedioxy-2′-oxo-$\Delta^{3',5',8'}$-8.1-lignan (**241**)	*P. wightii*	[199]
Eupomatene (**242**)	*P. interruptum*	[113]
Eupomatenoid-5 (**243**)	*P. decurrens*	[220]
Eupomatenoid-6 (**244**)	*P. decurrens*	[220]
Eupomatenoid-7 (**245**)	*P. ribesoides*	[96]

Table 4—*continued.*

Compound	Plant(s)	Reference(s)
Fargesone A (**246**)	*P. wightii*	[199]
Fargesone B (**247**)	*P. wightii*	[199]
Futoenone (**248**)	*P. futokadsura*	[223, 224]
Futoquinol/Hancinone D (**249**)	*P. argyrophylum*	[25]
	P. futokadsura	[223, 225, 226]
	P. hancei	[89]
	P. schmidtii	[156]
	P. wightii	[48]
Hancinol (**250**)	*P. hancei*	[79]
Hancinone (**251**)	*P. hancei*	[221]
	P. wightii	[218]
Hancinone B (**252**)	*P. hancei*	[227]
Hancinone C (**253**)	*P. hancei*	[227]
	P. polysyphorum	[206]
	P. wallichii	[89]
Hookerinone A (**254**)	*P. hookeri*	[228]
(7*R*,8*R*,3′*R*)-7-Hydroxy-3′,4′-dimethoxy-3,4-methylenedioxy-6′-oxo-$\Delta^{1',4',8'}$-8.3′-lignan (**255**)	*P. wightii*	[118]
2′-Hydroxy-4′-oxo-3,4,5′-trimethoxy-$\Delta^{5',8'}$-8.1′,7.3′-lignan (**256**)	*P. kadsura*	[216]
rel-(7*S*,8*S*)-$\Delta^{8'}$-4-Hydroxy-3-methoxy-3′,4′-methylenedioxy-7.O.2′,8.3′-lignan (**257**)	*P. capense*	[217]
Isodihydrofutoquinol A (**258**)	*P. futokadsura*	[225]
	P. hookeri	[228]
	P. schmidtii	[156]
	P. wightii	[188]
Isodihydrofutoquinol B (**259**)	*P. boehimerifolium*	[228]
	P. futokadsura	[225]
	P. hamiltoni	[228]
	P. hookeri	[228]
	P. schmidtii	[156]
	P. wightii	[188]
Isofutoquinol A (**260**)	*P. futokadsura*	[225]
Isofutoquinol B (**261**)	*P. argyrophylum*	[25]
	P. futokadsura	[225]
Kadsurenin B (**262**)	*P. kadsura*	[229]
Kadsurenin C (**263**)	*P. kadsura*	[229]
Kadsurenin I (**264**)	*P. kadsura*	[230]
Kadsurenin J (**265**)	*P. kadsura*	[230]
Kadsurenin K (**266**)	*P. kadsura*	[213]
Kadsurenin L (**267**)	*P. kadsura*	[213]
(+)-Kadsurenone (**268**)	*P. futokadsura*	[211, 212, 231]
	P. hancei	[89, 221]
	P. wallichii	[89]
Kadsurin A (**269**)	*P. argyrophylum*	[25]
	P. attenuatum	[232]
	P. boehimerifolium	[228]
	P. cubeba	[233]
	P. futokadsura	[212]
	P. hamiltoni	[228]
	P. schmidtii	[156]
	P. wightii	[218]

Table 4—*continued.*

Compound	Plant(s)	Reference(s)
Kadsurin B (**270**)	*P. argyrophylum* *P. attenuatum* *P. futokadsura* *P. schmidtii* *P. wightii*	[25, 51] [232] [212] [53] [218]
Lancifolin C (**271**)	*P. argyrophylum* *P. schmidtii* *P. wightii*	[25] [53] [118]
(+)-Lancifolin D (**272**)	*P. argyrophylum* *P. polysyphorum* *P. schmidtii* *P. wightii*	[25] [206] [53] [118]
(7*R*,8*R*,1′*S*)-$\Delta^{8'}$-1′-Methoxy-3,4-methylenedioxy-1′,6-dihydro-6′-oxo-7.O.4′,8.3′-lignan (**273**)	*P. argyrophylum* *P. clarkii* *P. kadsura*	[25] [200] [234]
rel-(7*S*,8*S*,1′*R*,3′*R*)-$\Delta^{8'}$-5′-Methoxy-3,4-methylenedioxy-1′,2′,3′,4′-tetrahydro-2′,4′-dioxo-7.3′,8.1′-lignan (**274**)	*P. clarkii*	[200]
(7*R*,8*R*,1′*R*)-$\Delta^{8'}$-3,4-Methylenedioxy-1′-methoxy-1′,6′-dihydro-6′-oxo-7.O.4′,8.3′-lignan (**275**)	*P. kadsura*	[234]
(7*R*,8*R*,1′*S*)-$\Delta^{8'}$-3,4-Methylenedioxy-5′-methoxy-1′,4′-dihydro-4′-oxo-7.O.2′,8.1′-lignan (**276**)	*P. kadsura*	[234]
(−)-Piperenone (**277**)	*P. cubeba* *P. cuneifolium* *P. futokadsura* *P. nigrum* *P. schmidtii* *P. wightii*	[233] [194] [235] [236] [53] [218]
Polysyphorin (**278**)	*P. polysyphorum*	[206]
Puberulin A (**279**)	*P. puberulum*	[215]
Puberulin B (**280**)	*P. puberulum*	[215]
Puberulin C (**281**)	*P. puberulum*	[215]
Schimiditin (**282**)	*P. schmidtii*	[53, 214]
(7*S*,8*R*,3′*S*,4′*R*,6′*S*)-$\Delta^{8'}$-3′,4′,5′,6′-Tetrahydro-6′-hydroxy-3,3′,4,4′-tetramethoxy-8.3′,7.O.4′-lignan (**283**)	*P. wightii*	[218]
rel-(7*R*,8*R*,3′*R*,4′*S*)-$\Delta^{8'}$-3′,4′,5′,6′-Tetrahydro-6′-oxo-3,4-methylenedioxy-3′,4′-dimethoxy-8.3′,7.O.4′-lignan (**284**)	*P. wightii*	[48]
(7*S*,8*S*,1′*R*)-$\Delta^{8'}$-3,4,5′-Trimethoxy-1′,4′-dihydro-4′-oxo-7.O.2′,8.1′-lignan (**285**)	*P. kadsura*	[234]
(7*S*,8*S*,1′*S*)-$\Delta^{8'}$-1′,3,4-Trimethoxy-1′,6′-dihydro-6′-oxo-7.O.4′,8.3′-lignan (**286**)	*P. kadsura*	[234]
(7*S*,8*S*,3′*R*)-$\Delta^{8'}$-3,3′,4-Trimethoxy-3′,6′-dihydro-6′-oxo-7.O.4′,8.3′-lignan (**287**)	*P. clarkii*	[200]
rel-(7*S*,8*R*)-$\Delta^{8'}$-3,4,5′-Trimethoxy-7-hydroxy-8.O.3′-lignan (**288**)	*P. capense*	[217]
(+)-Virolongin (**289**)	*P. polysyphorum*	[206]
Wallichinine (**290**)	*P. capense* *P. polysyphorum* *P. wallichii* *P. wightii*	[217] [206] [89] [188]



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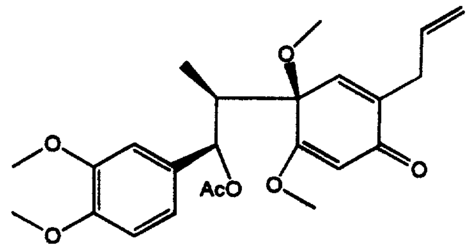

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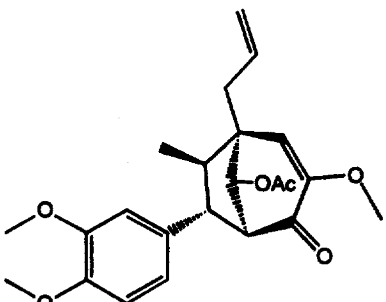

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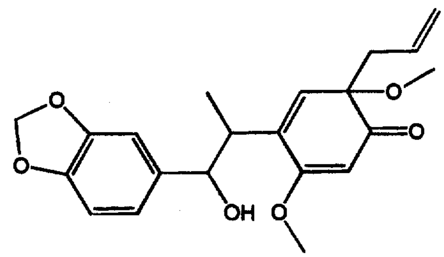

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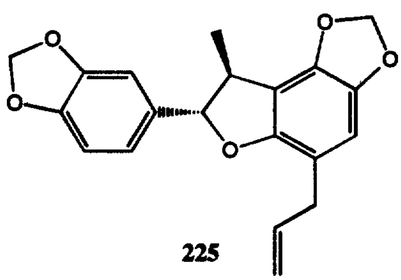

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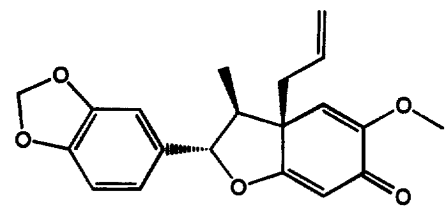

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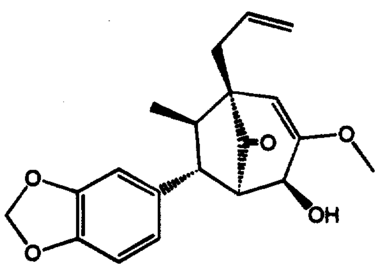

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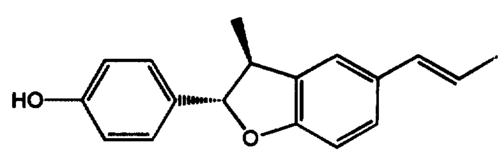

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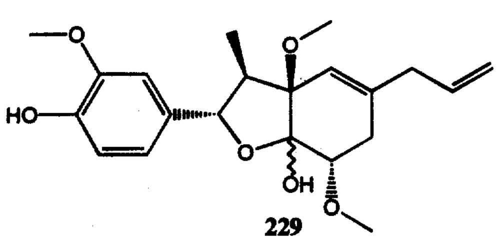

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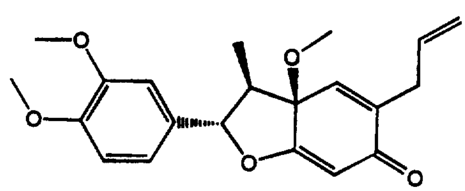

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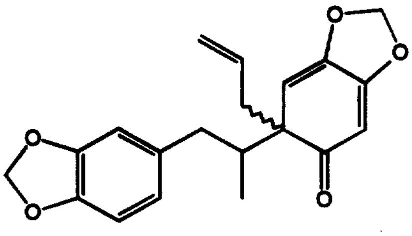

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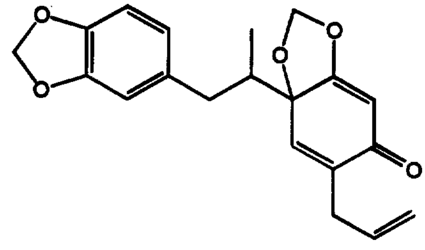

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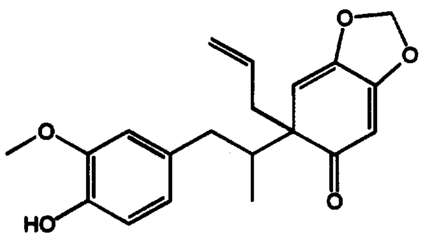

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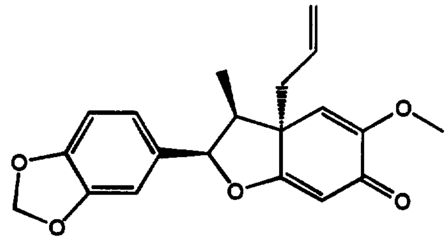

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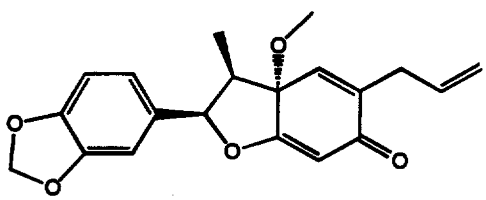

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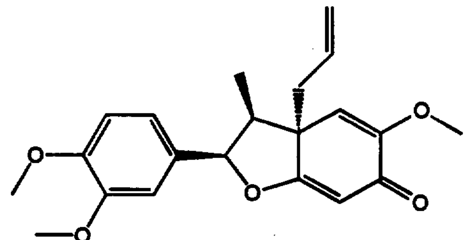

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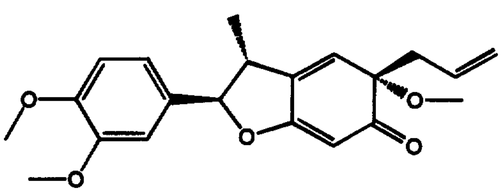

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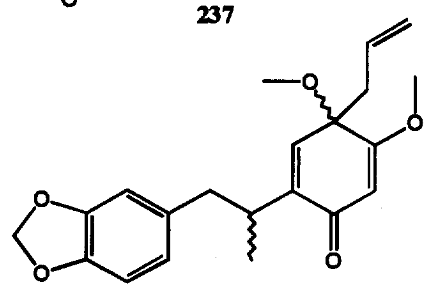

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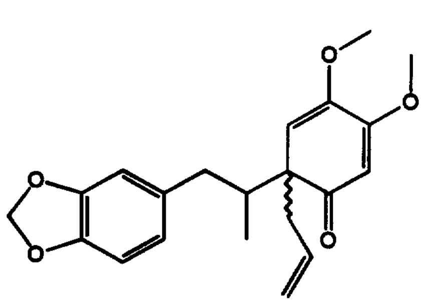

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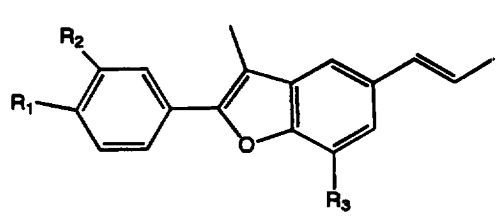
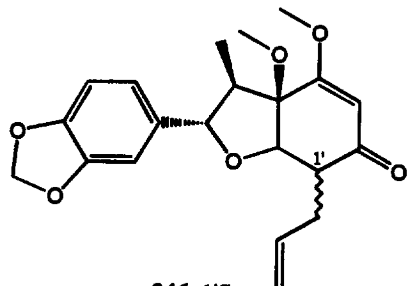
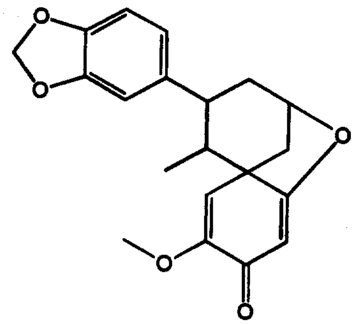


242 $R_1+R_2=OCH_2O$; $R_3=OCH_3$
243 $R_1=OH$; $R_2=OCH_3$; $R_3=H$
244 $R_1=OH$; $R_2=R_3=H$
245 $R_1=OH$; $R_2=R_3=OCH_3$



246 1'S
247 1'R



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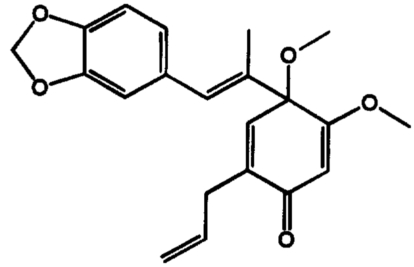

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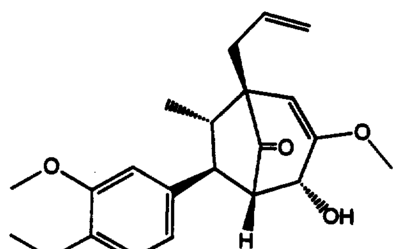

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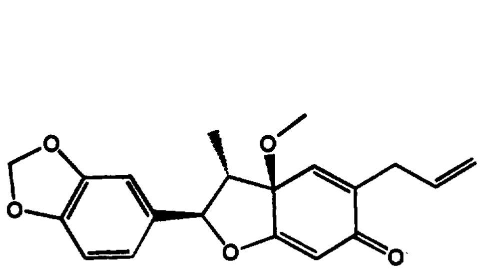

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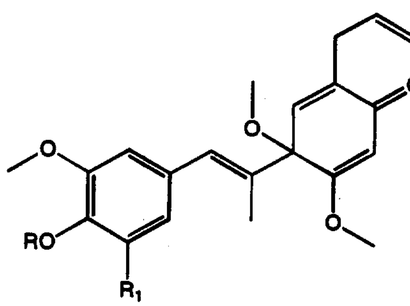
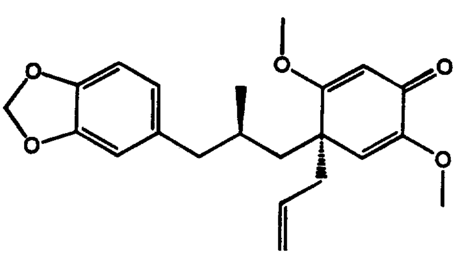


252 $R=R_1=H$
253 $R=CH_3$; $R_1=OCH_3$



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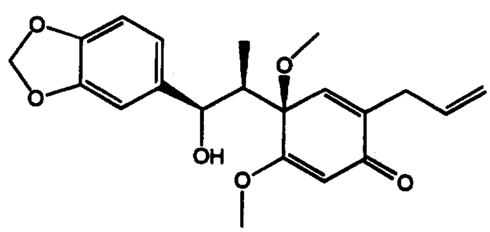

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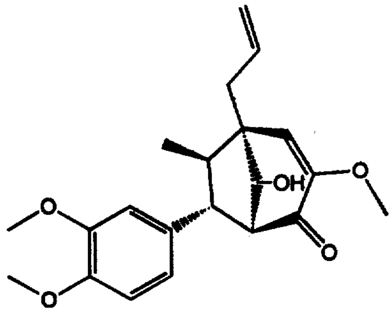

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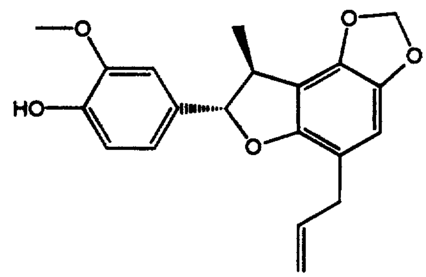

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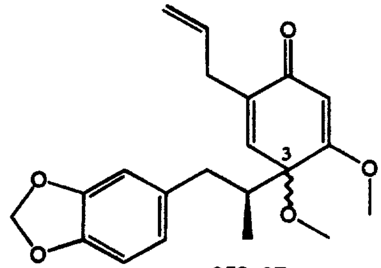
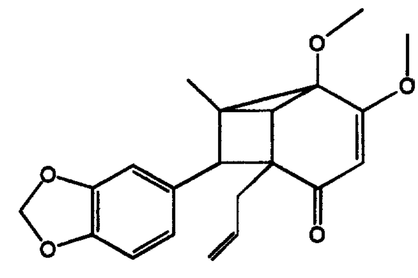


258 3R
259 3S



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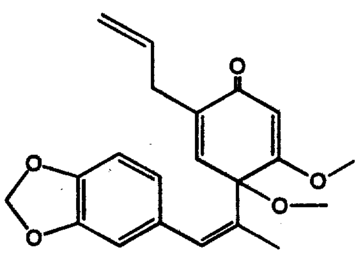

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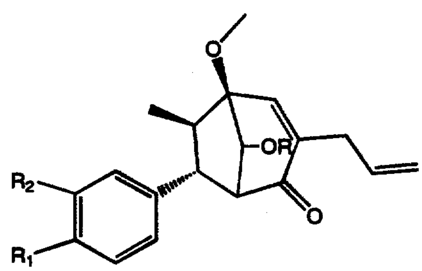
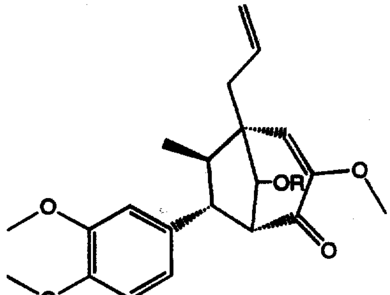
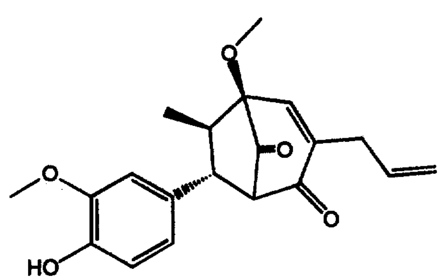


262 R=Ac; $R_1+R_2=OCH_2O$
263 R=H; $R_1+R_2=OCH_2O$
267 R=Ac; $R_1=R_2=OCH_3$



264 R=H
265 $R=COCH_3$



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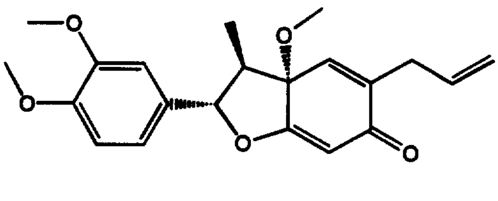

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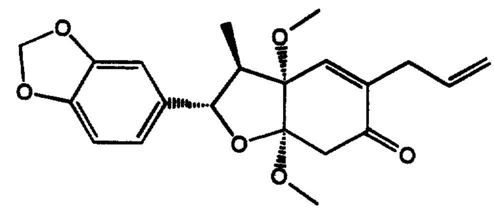

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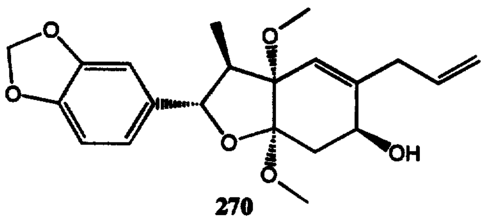

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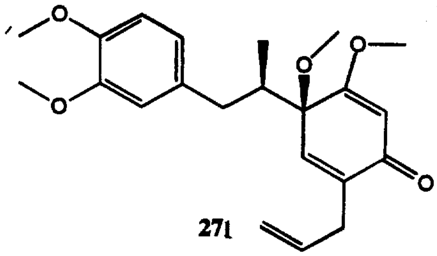

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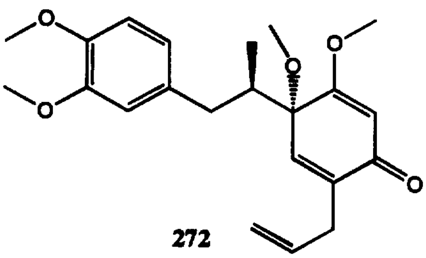

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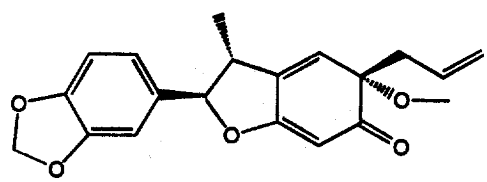

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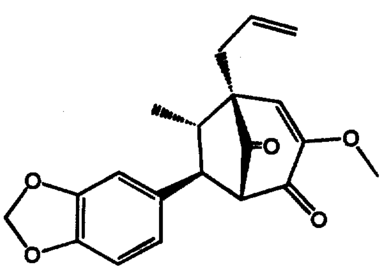

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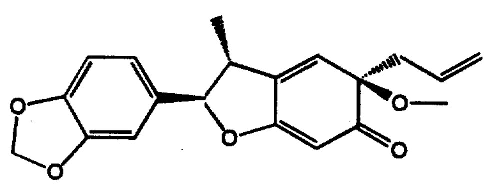

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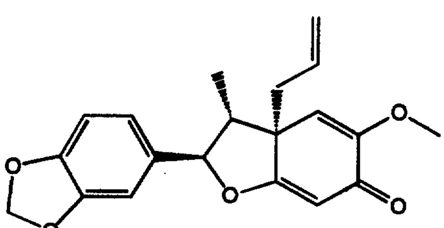

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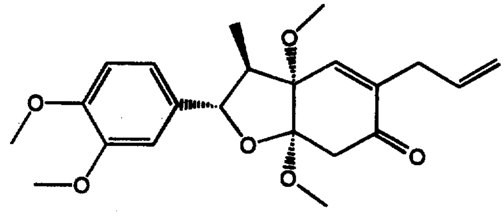

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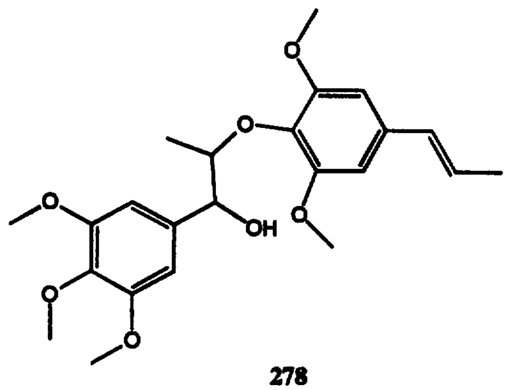

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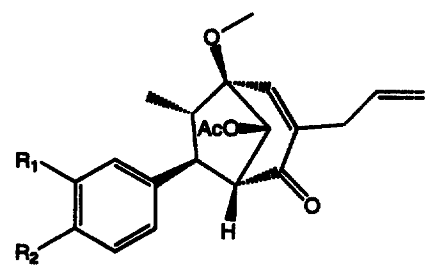
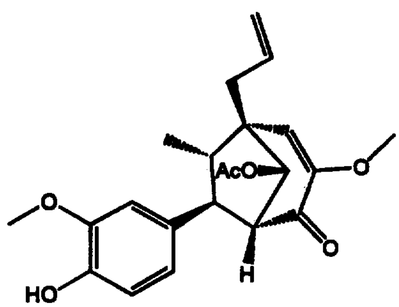


279 $R_1=R_2=OCH_3$
280 $R_1=R_2=$ -O-CH_2-O-



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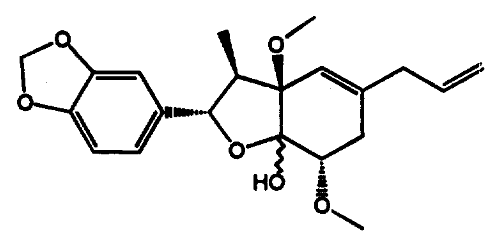

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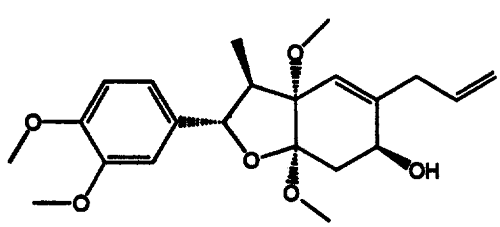

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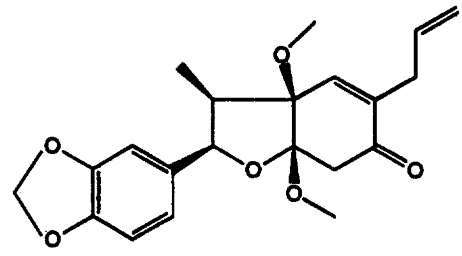

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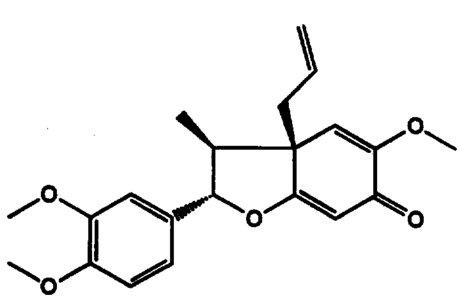

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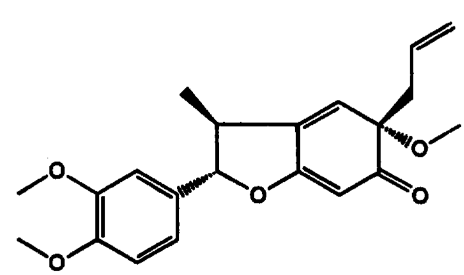

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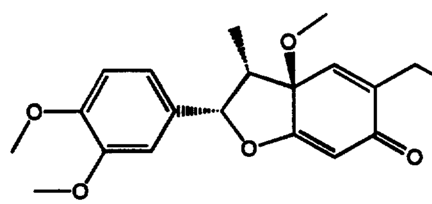

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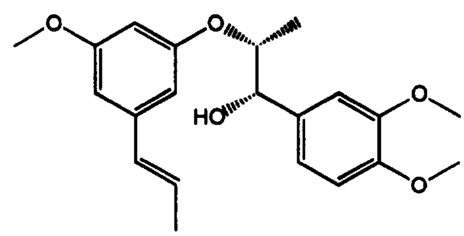

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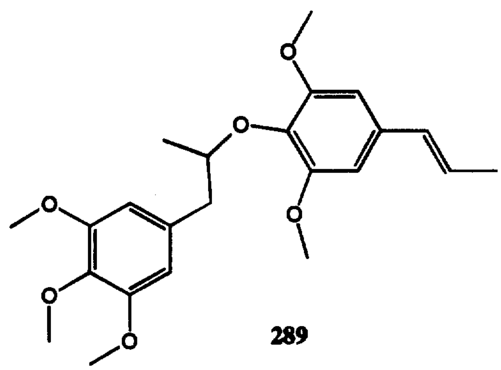

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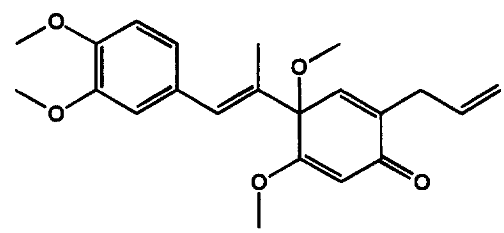

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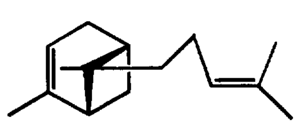

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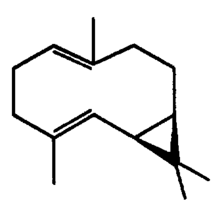

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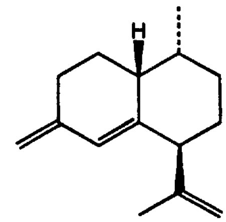

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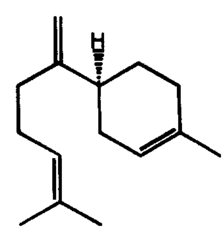

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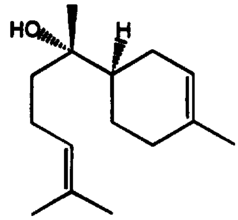

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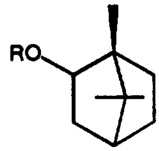
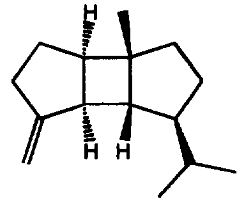


296 R=H
297 R=$COCH_3$



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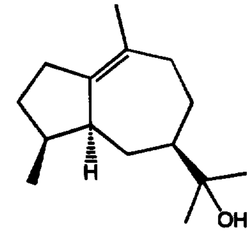


299

TERPENES

Most of the terpenes which have been isolated from *Piper* species (Table 5) are either monoterpenes or sesquiterpenes. Transphytol (**375**), a diterpene has been isolated from *P. decurrens* [220], *P. methysticum* [237], *P. auritum* [238] and *P. aduncum* [239].

Table 5. Terpenes from *Piper* species

Compound	Plant(s)	Reference(s)
α-Bergamotene (**291**)	*P. guineense*	[164]
	P. nigrum	[177, 240]
Bicyclogermacrene (**292**)	*P. mikanianum*	[241]
Bicyclosesquiphellandrene (**293**)	*P. cubeba*	[242]
β-Bisabolene (**294**)	*P. attenuatum*	[243]
	P. auritum	[153, 166]
	P. nigrum	[240]
α-Bisabolol (**295**)	*P. guineense*	[164]
Borneol (**296**)	*P. auritum*	[166]
	P. guineense	[164]
Borneol acetate (**297**)	*P. auritum*	[166]
β-Bourbonene (**298**)	*P. argyrophylum*	[51]
	P. auritum	[166]
	P. marginatum	[165]
Bulnesol (**299**)	*P. guineense*	[164]
5,10(15)-Cadienen-4-ol (**300**)	*P. nigrum*	[78]
Cadina-1(10),4-diene(δ-cadinene) (**301**)	*P. argyrophylum*	[51]
	P. auritum	[153, 166]
	P. guineense	[164]
	P. marginatum	[165]
	P. nigrum	[240]
Cadina-1,4-diene-3-ol (**302**)	*P. guineense*	[164]
Cadina-4(14),5-diene (**303**)	*P. cubeba*	[242, 244]
α-Cadinol (**304**)	*P. guineense*	[164]
	P. marginatum	[165]
	P. nigrum	[245]
Calamenene (**305**)	*P. guineense*	[164]
	P. nigrum	[246]
Camphene (**306**)	*P. auritum*	[163, 166, 247]
	P. betle	[153]
	P. futokadsura	[226]
	P. guineense	[164]
	P. hispidum	[248]
	P. nigrum	[249]
Camphor (**307**)	*P. aduncum*	[171]
	P. auritum	[166, 247]
	P. guineense	[164]
Capentin (**308**)	*P. capense*	[250]
3-Carene (**309**)	*P. argyrophylum*	[51]
	P. auritum	[166]
	P. guineense	[164]
	P. marginatum	[165]
	P. nigrum	[153]
(+)-4-Carene (**310**)	*P. cubeba*	[251]
Carveol (**311**)	*P. nigrum*	[177]

Table 5—*continued.*

Compound	Plant(s)	Reference(s)
Carvone (**312**)	*P. nigrum*	[177]
β-Caryophyllene (**313**)	*P. argyrophylum*	[51]
	P. attenuatum	[243]
	P. auritum	[153, 166, 252]
	P. betle	[253]
	P. gaudichaudianum	[241]
	P. guineense	[164]
	P. marginatum	[165]
	P. mikanianum	[241]
	P. nigrum	[240, 246]
Caryophyllene oxide (**314**)	*P. aduncum*	[152]
	P. auritum	[153, 166, 252]
	P. brachystachyum	[254]
	P. guineense	[164]
	P. hookeri	[254]
	P. nepalense	[91]
Caryophyllenol-II (**315**)	*P. aduncum*	[23]
1,4-Cineol (**316**)	*P. cubeba*	[251]
1,8-Cineol (**317**)	*P. auritum*	[166]
	P. betle	[153]
	P. cubeba	[175]
	P. marginatum	[172]
	P. nigrum	[138]
Citronellol (**318**)	*P. nigrum*	[246]
α-Copaene (**319**)	*P. auritum*	[166]
	P. cubeba	[255]
	P. guineense	[164]
	P. marginatum	[165]
	P. nigrum	[240]
α-Cubebene (**320**)	*P. argyrophylum*	[51]
	P. cubeba	[175]
	P. guineense	[164]
	P. nigrum	[240]
Cubebol (**321**)	*P. aduncum*	[23]
	P. cubeba	[256]
Cubenol (**322**)	*P. guineense*	[164]
Curcumene (**323**)	*P. nigrum*	[177]
Cryptone (**324**)	*P. nigrum*	[246]
p-Cymene (**325**)	*P. argyrophylum*	[51]
	P. auritum	[166]
	P. betle	[153]
	P. cubeba	[175]
	P. guineense	[164]
	P. longum	[257]
	P. marginatum	[165, 182]
	P. nigrum	[253]
p-Cymen-8-ol (**326**)	*P. auritum*	[166]
	P. guineense	[164]
	P. nigrum	[177]
p-Cymen-8-ol methyl ether (**327**)	*P. nigrum*	[78]
Dihydrocarveol (**328**)	*P. longum*	[257]
	P. nigrum	[246]

Table 5—*continued*.

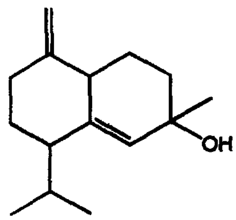
Compound	Plant(s)	Reference(s)
α-Elemene (**329**)	*P. auritum*	[166]
	P. guineense	[164]
	P. hispidum	[248]
	P. marginatum	[165]
	P. nigrum	[240]
α-Elemol (**330**)	*P. guineense*	[164]
	P. marginatum	[165]
	P. ribesioides	[96]
β-Eudesmol (**331**)	*P. marginatum*	[165]
β-Farnesene (**332**)	*P. guineense*	[164]
	P. nigrum	[258]
(2*Z*,6*E*)-Farnesol (**333**)	*P. nigrum*	[245]
Germacrene D (**334**)	*P. arboreumlatifolium*	[248]
	P. cubeba	[256]
	P. guineense	[164]
	P. kadsura	[259]
β-Guaiene (**335**)	*P. nigrum*	[245]
Guaiol (**336**)	*P. guineense*	[164]
	P. nigrum	[245]
α-Gurjunene (**337**)	*P. argyrophylum*	[51]
	P. guineense	[164]
α-Humulene (**338**)	*P. aduncum*	[152]
	P. auritum	[166]
	P. gaudichaudianum	[141]
	P. marginatum	[165]
	P. nigrum	[240]
Humulene epoxide-I (**339**)	*P. aduncum*	[152]
Ishwarol (**340**)	*P. amalago*	[260]
Isoborneol (**341**)	*P. guineense*	[164]
Isocaryophyllene (**342**)	*P. nigrum*	[258]
4-Isopropyl-1-methylcyclohex-1-en-4-ol (**343**)	*P. cubeba*	[251]
(−)-Ledol (**344**)	*P. clusii*	[191]
Limonene (**345**)	*P. argyrophylum*	[51]
	P. auritum	[166]
	P. betle	[153]
	P. cubeba	[175]
	P. futokadsura	[147]
	P. guineense	[164]
	P. marginatum	[165]
	P. mikanianum	[73]
	P. nigrum	[138]
Linalool (**346**)	*P. auritum*	[166]
	P. gaudichaudianum	[241]
	P. guineense	[164]
	P. hostmannianum	[261]
	P. marginatum	[165]
	P. nigrum	[238]
2,8(9)-*p*-Menthadien-4-ol (**347**)	*P. nigrum*	[73]
3,8(9)-*p*-Menthadien-1-ol (**348**)	*P. nigrum*	[73]

Table 5—*continued.*

Compound	Plant(s)	Reference(s)
(−)-Muurolene (**349**)	*P. argyrophylum*	[51]
	P. auritum	[153, 166, 252]
	P. cubeba	[256]
	P. marginatum	[175]
	P. nigrum	[258]
T-Muurolol (**350**)	*P. guineense*	[164]
Myrcene (**351**)	*P. argyrophylum*	[51]
	P. auritum	[166]
	P. betle	[168]
	P. cubeba	[175]
	P. guineense	[164]
	P. marginatum	[165]
	P. nigrum	[238, 253]
Nerolidol (**352**)	*P. falconeri*	[46]
	P. guineense	[164]
	P. marginatum	[165]
	P. nigrum	[177]
β-Ocimene (**353**)	*P. cubeba*	[175]
	P. guineense	[164]
	P. marginatum	[165]
	P. nigrum	[245]
α-Phellandrene (**354**)	*P. auritum*	[166]
	P. cubeba	[175]
	P. guineense	[164]
	P. marginatum	[165]
	P. nigrum	[245]
β-Phellandrene (**355**)	*P. auritum*	[166]
	P. cubeba	[175]
	P. guineense	[164]
	P. nigrum	[253]
α-Pinene (**356**)	*P. argyrophylum*	[51]
	P. auritum	[166]
	P. betle	[153]
	P. cubeba	[175]
	P. futokadsura	[147]
	P. guineense	[164]
	P. marginatum	[165]
	P. nigrum	[253]
β-Pinene (**357**)	*P. argyrophylum*	[51]
	P. auritum	[166]
	P. betle	[153]
	P. cubeba	[175]
	P. futokadsura	[147]
	P. gaudichaudianum	[241]
	P. guineense	[164]
	P. marginatum	[165]
	P. nigrum	[253]
β-Pinone (**358**)	*P. nigrum*	[78]
Piperitone (**359**)	*P. aduncum*	[46, 163, 252, 262]
	P. guineense	[164]
Sabinene (**360**)	*P. argyrophylum*	[51]
	P. auritum	[166]
	P. cubeba	[175]
	P. futokadsura	[147]
	P. guineense	[164]
	P. marginatum	[165]
	P. nigrum	[253]

Table 5—*continued.*

Compound	Plant(s)	Reference(s)
cis-Sabinene hydrate (**361**)	*P. auritum*	[166]
	P. guineense	[164]
α-Santalene (**362**)	*P. nigrum*	[240]
α-Selinene (**363**)	*P. nigrum*	[240]
β-Selinene (**364**)	*P. nigrum*	[240]
Sesquisabinene (**365**)	*P. nigrum*	[178]
Spathulenol (**366**)	*P. aduncum*	[23]
	P. auritum	[166]
	P. guineense	[164]
α-Terpinene (**367**)	*P. auritum*	[166, 247]
	P. betle	[263]
	P. cubeba	[175]
	P. marginatum	[165]
	P. nigrum	[253]
γ-Terpinene (**368**)	*P. auritum*	[166, 247]
	P. cubeba	[175]
	P. guineense	[164]
	P. marginatum	[165]
	P. nigrum	[253]
Terpinen-4-ol (**369**)	*P. guineense*	[164]
Terpinen-5-ol (**370**)	*P. nigrum*	[78]
α-Terpineol (**371**)	*P. betle*	[263]
	P. guineense	[164]
	P. nigrum	[264]
α-Terpineol acetate (**372**)	*P. betle*	[263]
Terpinolene (**373**)	*P. auritum*	[166, 247]
	P. cubeba	[175]
	P. guineense	[164]
	P. longum	[257]
	P. marginatum	[165]
	P. nigrum	[253]
α-Thujene (**374**)	*P. argyrophylum*	[51]
	P. auritum	[166]
	P. cubeba	[175]
	P. guineense	[164]
	P. longum	[257]
	P. marginatum	[165]
	P. nigrum	[253]
Transphytol (**375**)	*P. aduncum*	[239]
	P. auritum	[238]
	P. decurrens	[220]
	P. methysticum	[237]
1,1,4-Trimethylcyclohepta-2,4-dien-6-one (**376**)	*P. nigrum*	[78]
Thymol (**377**)	*P. lenticellosum*	[265]
Viridiflorol (**378**)	*P. aduncum*	[23]
Zingiberene (**379**)	*P. longum*	[257]



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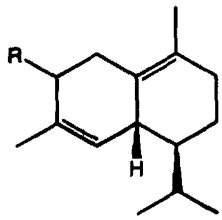

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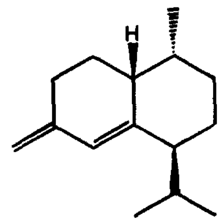
302 R=OH



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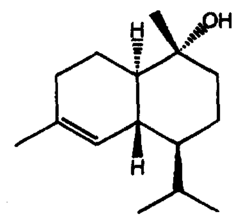

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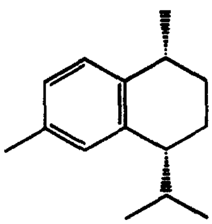

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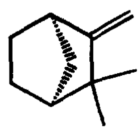

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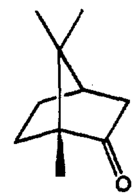

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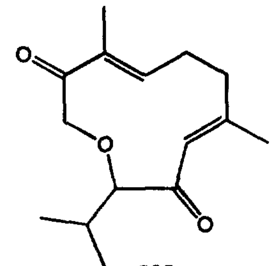

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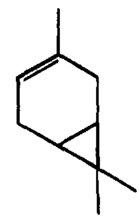

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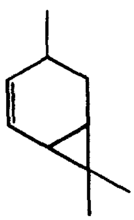

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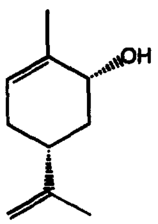

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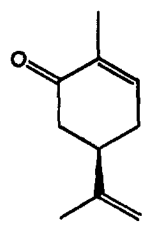

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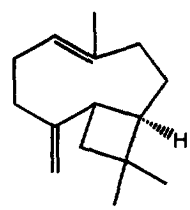

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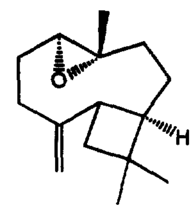

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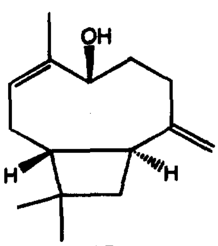

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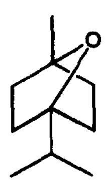

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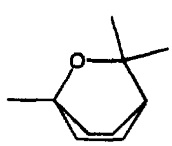

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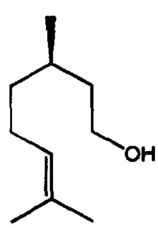

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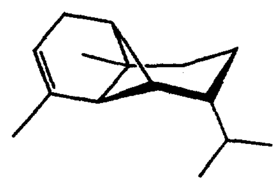

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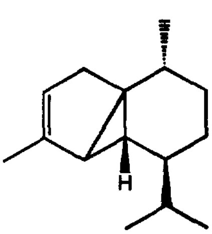

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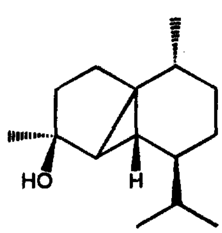

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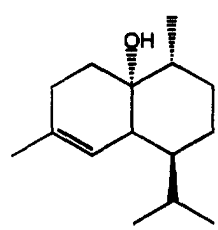

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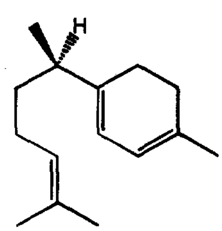

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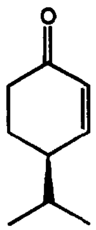

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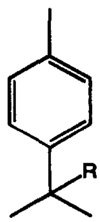
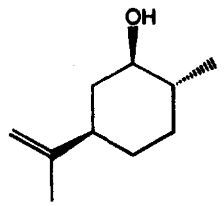


325 R=H
326 R=OH
327 R=OCH_3



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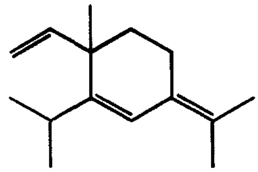

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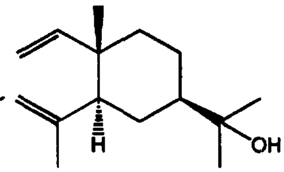

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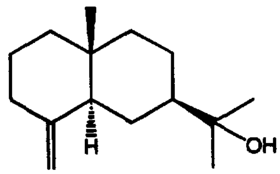

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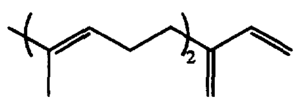

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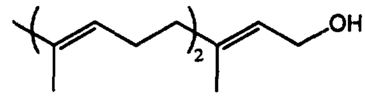

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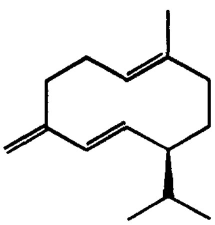

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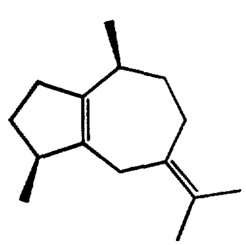

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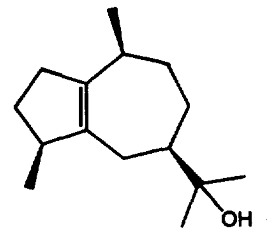

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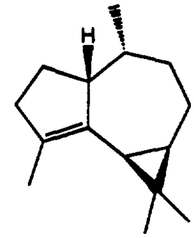

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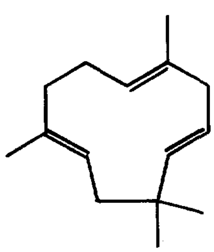

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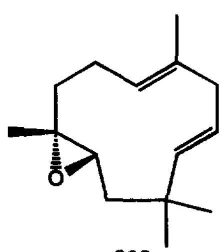

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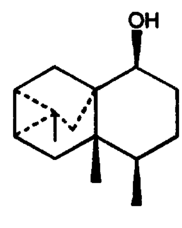

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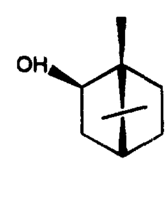

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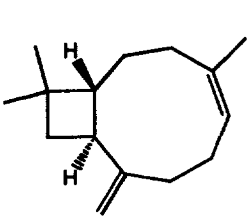

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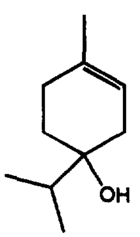

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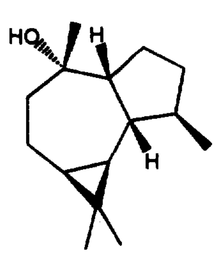

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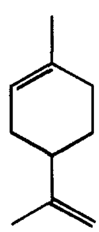

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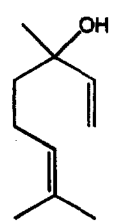

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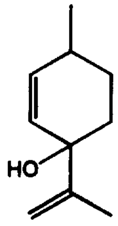
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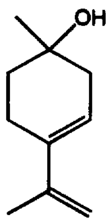
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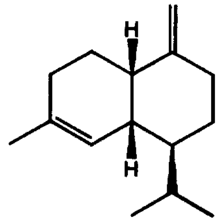
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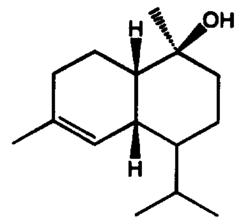
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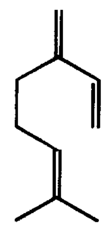
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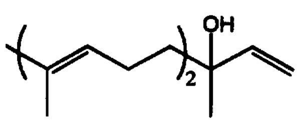
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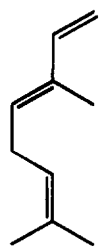
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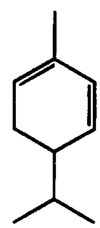
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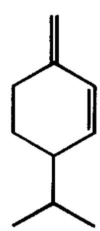
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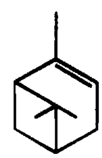
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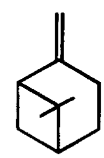
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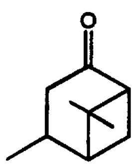
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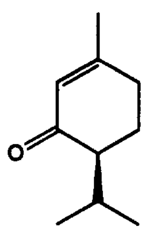
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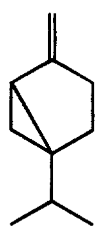
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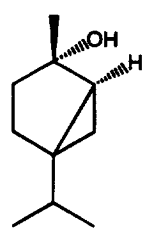
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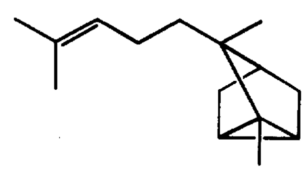
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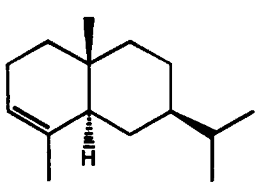
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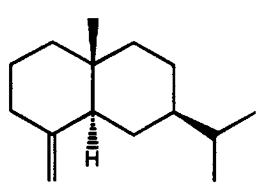
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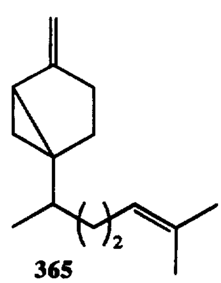
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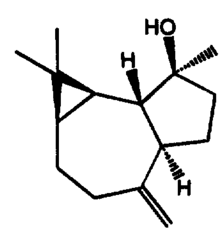
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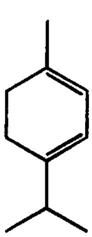
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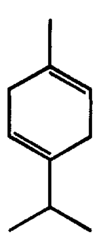
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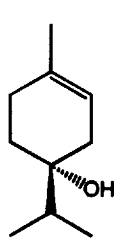
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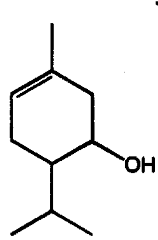
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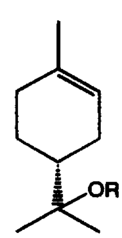
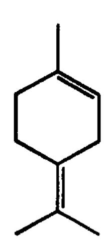

371 R=H
372 $R=COCH_3$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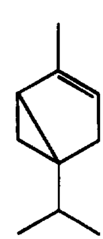
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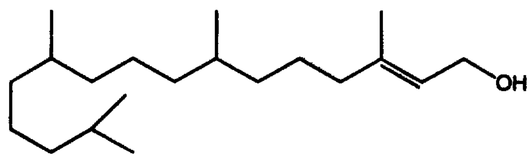

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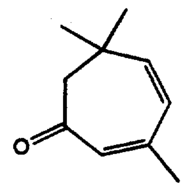

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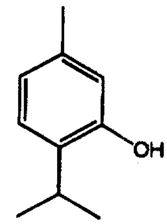

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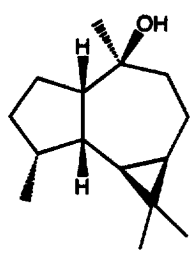

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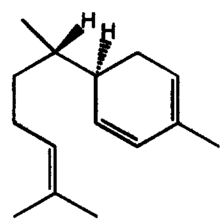

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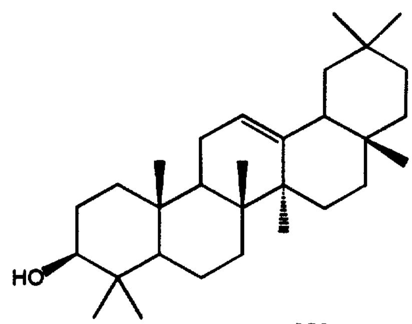

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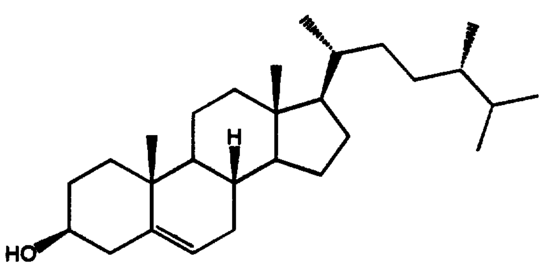

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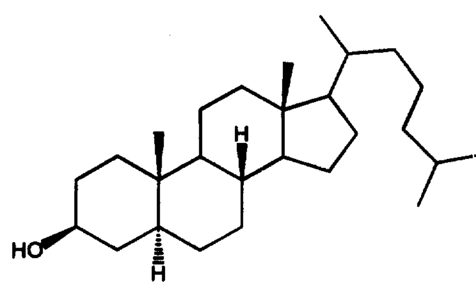

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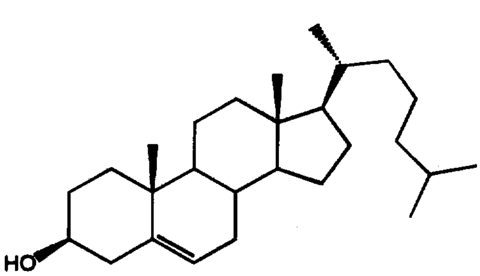

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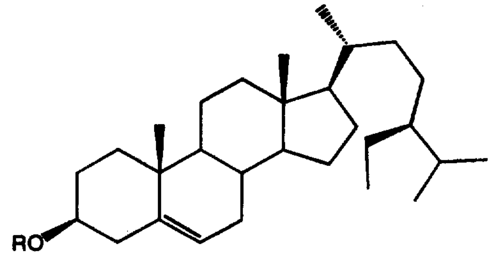


384 R=glucosyl
387 R=H
388 R=palmitoyl

STEROIDS

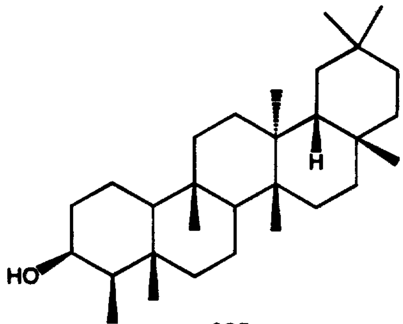
Sitosterol (**387**), ursolic acid (**392**) and ursolic acid-3β-acetate (**393**) isolated from *P. betle* [266] inhibited arachidonic acid-induced platelet aggregation in decreasing order of potency. Sitosterol (**387**) and ursolic acid (**392**) inhibited platelet activating factor induced aggregation while only sitosterol (**387**) inhibited ADP-induced platelet aggregation. Ursolic acid (**392**) (25–100 mg kg^{-1}) exhibited a concentration dependant anti-inflammatory effect. The steroids isolated from different *Piper* species are listed in Table 6.

Table 6. Steroids from *Piper* species

Compound	Plant(s)	Reference(s)
β-Amyrin (**380**)	*P. amalgo*	[5]
Campesterol (**381**)	*P. chiadoense*	[49]
	P. methysticum	[237]
Cholestanol (**382**)	*P. aurantiacum*	[267]
Cholesterol (**383**)	*P. aurantiacum*	[267]
	P. methysticum	[237]
Daucosterol (**384**)	*P. macropodum*	[98]
	P. peepuloides	[140]
	P. puberculum	[203]
epi-Friedelanol (**385**)	*P. aurantiacum*	[268]
Friedelin (**386**)	*P. aurantiacum*	[268]
Sitosterol (**387**)	*P. aduncum*	[46, 269]
	P. acutisleginum	[41]
	P. amalago	[5]
	P. argyrophylum	[51]
	P. attenuatum	[46, 205, 232]
	P. aurantiacum	[141, 268]
	P. auritum	[238]
	P. austrosinense	[101]
	P. betle	[41, 162, 266, 270, 271]
	P. brachystachyum	[38, 155]
	P. callosum	[120]
	P. chiadoense	[49]
	P. clarkii	[272]
	P. clusii	[189]
	P. divaricatum	[161]
	P. falconeri	[11]
	P. futokadsura	[223]
	P. hookeri	[273]
	P. hancei	[227]
	P. hostmannianum	[261]
	P. khasiana	[46]
	P. longum	[124]
	P. macropodum	[98]
	P. manausense	[44]
	P. methysticum	[237]
	P. nepalense	[91]
	P. nigrum	[126]
	P. pedicellosum	[46]
	P. peepuloides	[46, 110]
	P. retrofractum	[120]
	P. ribesioides	[92, 96]
	P. sanctum	[274]
	P. sarmentosum	[93, 275]
	P. steerni	[95]
	P. sumatranum	[160, 192]
	P. taboganum	[276]

Table 6—*continued.*

Compound	Plant(s)	Reference(s)
β-Sitosteryl palmitate (**388**)	*P. betle*	[41]
γ-Sitosterol (**389**)	*P. betle*	[162]
Stigmastanol (**390**)	*P. methysticum*	[237]
Stigmasterol (**391**)	*P. aduncum*	[262]
	P. betle	[270]
	P. chiadoense	[49]
	P. futokadsura	[223]
	P. guayranum	[30]
	P. longum	[123, 277]
	P. manausense	[52]
	P. methysticum	[237]
	P. taboganum	[276]
Ursolic acid (**392**)	*P. betle*	[266]
Ursolic acid 3β-acetate (**393**)	*P. betle*	[266]



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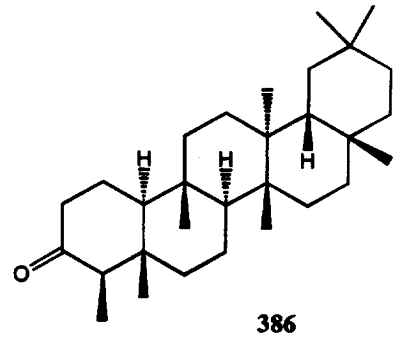

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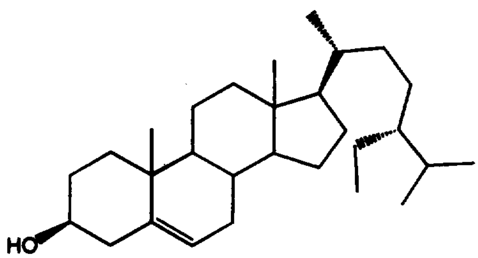

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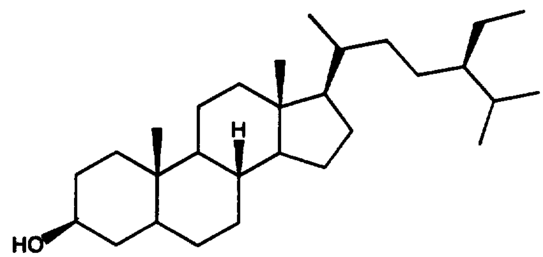

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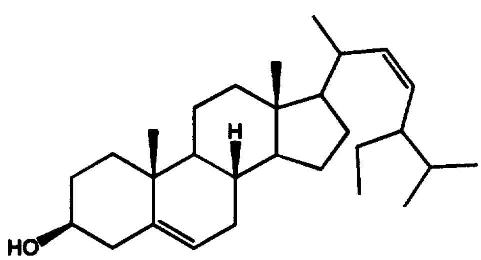

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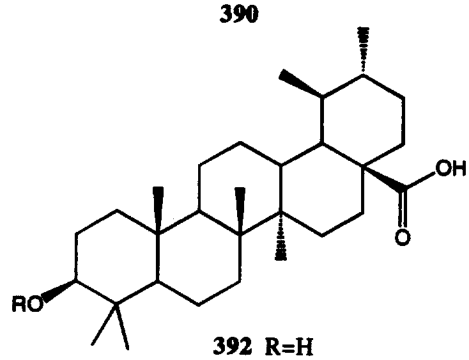
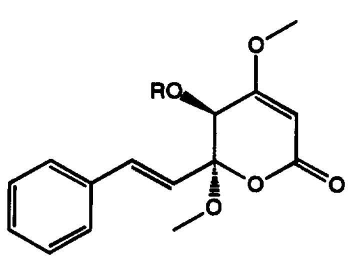
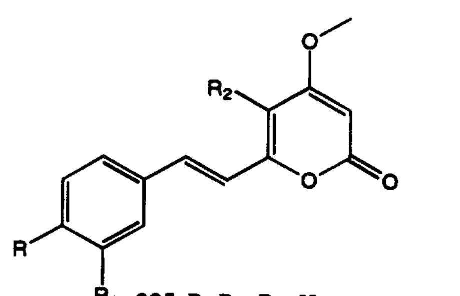


392 R=H
393 R=Ac



394 R=Ac
400 R=H



395 R=R_1=R_2=H
403 R+R_1=OCH_2O; R_2=OCH_3
404 R=R_1=OCH_3; R_2=H
407 R=OCH_3; R_1=R_2=H

KAWAPYRONES

Kawapyrones (δ-lactones having styryl/dihydrostyryl substituents), mainly isolated from *P. methysticum* (Table 7) act in pharmacological experiments as CNS depressant drugs. Meyer *et al.* [278–280] found depression of spontaneous motor activity, potentiation of anaesthesis, anticonvulsive effects against electroshock, pentylenetetranol-induced seizures, a centrally caused muscle relaxation and a blocking effect of polysynaptic reflexes due to this class of compounds. On account of these properties, they studied the antistrychnine action of the kawapyrones [281]. The mice poisoned with various doses of strychnine, dihydrokawain (**396**), dihydromethysticin (**398**), kawain (**402**) and methysticin (**405**) were tested in comparison with mephenesin and phenobarbital. All the kawapyrones showed a marked antagonistic effect upon the convulsant and lethal action of strychnine. Methysticin (**405**) proved to be the most potent compound of all the kawapyrones tested, it exhibited a higher protective activity against strychnine poisoning than mephenesin. The kawapyrones other than the compound **398** antagonized strychnine without affecting the behaviour of the animals, whereas equally effective doses of mephenesin and phenobarbital caused ataxia and paralysis. Yangonin (**407**) isolated from *P. methysticum* inhibited the growth of the amoeba, *Entamoeba histolytica* [282].

Table 7. Kawapyrones from *Piper* species

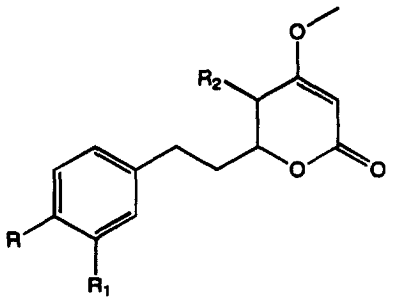
Compound	Plant(s)	Reference(s)
(+)-(5*S*,6*S*)-5-Acetoxy-4,6-dimethoxy-6-*E*-styryl-5,6-dihydro-2H-pyran-2-one (**394**)	*P. sanctum*	[274]
Desmethoxyyangonin (**395**)	*P. methysticum*	[134, 283–286]
Dihydrokawain (**396**)	*P. methysticum*	[105, 134, 282–290]
Dihydrokawain-5-ol (**397**)	*P. methysticum*	[291]
Dihydromethysticin (**398**)	*P. methysticum*	[134, 282–288, 292, 293]
11,12-Dimethoxydihydrokawain (**399**)	*P. methysticum*	[294]
(+)-(5*S*,6*S*)-5-Hydroxy-4,6-dimethoxy-6-*E*-styryl-5,6-dihydro-2*H*-pyran-2-one (**400**)	*P. sanctum*	[295]
11-Hydroxy-12-methyoxydihydrokawain (**401**)	*P. methysticum*	[294]
Kawain (**402**)	*P. methysticum*	[105, 134, 282–287, 296]
5-Methoxy-5,6-dehydromethysticin (**403**)	*P. sanctum*	[297]
11-Methoxyyangonin (**404**)	*P. methysticum*	[298]
Methysticin (**405**)	*P. methysticum* *P. sanctum*	[282–287, 290, 292, 296, 299, 300] [297]
Tetrahydroyangonin (**406**)	*P. methysticum*	[134, 284, 301]
Yangonin (**407**)	*P. methysticum*	[282–285, 289, 290, 292, 296, 299, 300]

PIPEROLIDES

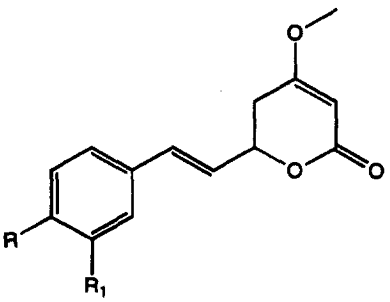
Piperolides are cinnamylidone butenolides. From the subterranean parts of *P. sanctum*, four piperolides have been isolated (Table 8).

Table 8. Piperolides from *Piper* species

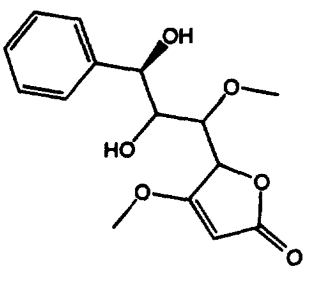
Compound	Plant(s)	Reference(s)
(−)-*threo*-(3*Z*)-5-(2,3-Dihydroxy-1-methoxy-3-phenylpropylidene)-4-methoxy-2-(5*H*)-furanone (**408**)	*P. sanctum*	[302]
7,8-Epoxypiperolide (**409**)	*P. sanctum*	[303, 304]
Methylenedioxypiperolide (**410**)	*P. sanctum*	[305]
Piperolide (**411**)	*P. sanctum*	[303–306]



396 $R=R_1=R_2=H$
397 $R=R_1=H$; $R_2=OH$
398 $R+R_1=OCH_2O$; $R_2=H$
399 $R=R_1=OCH_3$; $R_2=H$
401 $R=OCH_3$; $R_1=OH$; $R_2=H$
406 $R=OCH_3$; $R_1=R_2=H$



402 $R=R_1=H$
405 $R+R_1=OCH_2O$



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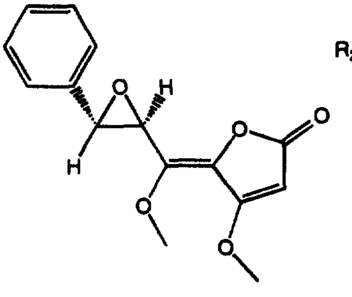

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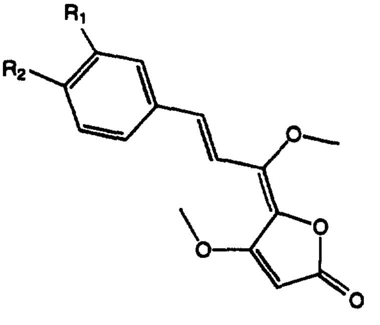
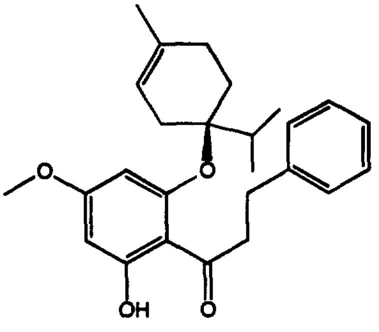


410 $R_1+R_2=OCH_2O$
411 $R_1=R_2=H$



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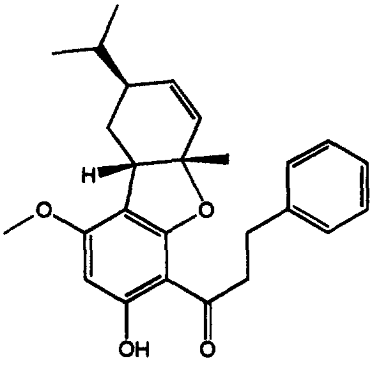

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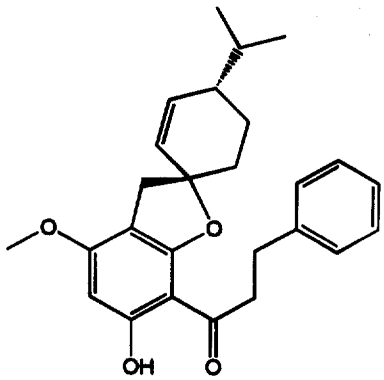
CHALCONES AND DIHYDROCHALCONES

Most of the chalcones and dihydrochalcones isolated from the *Piper* species are oxygenated at the C-2′, C-4′ and C-6′ positions (Table 9) and the B-ring is unsubstituted in all the chalcones and dihydrochalcones except asebogenin (**417**), flavokawains A and C (**420** and **422**) in which C-4 position is also oxygenated. Flavokawain C (**422**), a dihydrochalcone isolated from *P. methysticum* showed moderate activity against *Salmonella typhii* [296]. Orjala *et al.* [239] isolated five new unusual monoterpene-substituted dihydrochalcones, adunctins A–E (**412–416**) from the leaves of *P. aduncum*. They also investigated the antibacterial and cytotoxic potentials of the isolates.

Table 9. Chalcones and dihydrochalcones from *Piper* species

Compound	Plant(s)	Reference(s)
Adunctin A (**412**)	*P. aduncum*	[239]
Adunctin B (**413**)	*P. aduncum*	[239]
Adunctin C (**414**)	*P. aduncum*	[239]
Adunctin D (**415**)	*P. aduncum*	[239]
Adunctin E (**416**)	*P. aduncum*	[239]
Asebogenin (**417**)	*P. aduncum*	[307]
2′,3′-Dihydroxy-4′,6′-dimethoxychalcone (**418**)	*P. hispidum*	[308]
2′,6′-Dihydroxy-4′-methoxydihydrochalcone (**419**)	*P. aduncum*	[46, 179, 180, 269, 307]
	P. fadyenii	[180]
	P. hispidum	[179, 180]
Flavokawain A (**420**)	*P. methysticum*	[284, 299, 309]
Flavokawain B (**421**)	*P. methysticum*	[284, 299, 310, 311]
Flavokawain C (**422**)	*P. methysticum*	[296, 299, 312, 313]
2′-Hydroxy-3′,4′,6′-trimethoxychalcone (**423**)	*P. hispidum*	[308]
Methyllindaretin (**424**)	*P. aduncum*	[239]
Piperaduncin A (**425**)	*P. aduncum*	[307]
Piperaduncin B (**426**)	*P. aduncum*	[307]
Piperaduncin C (**427**)	*P. aduncum*	[307]



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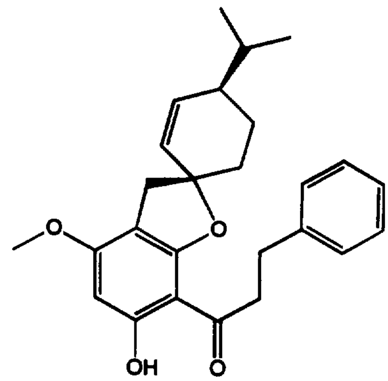

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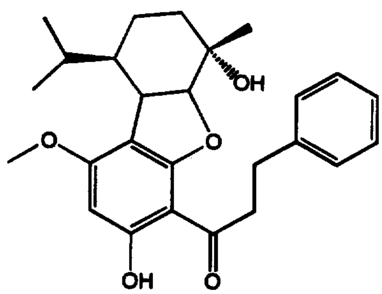

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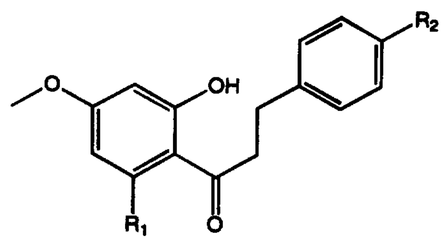
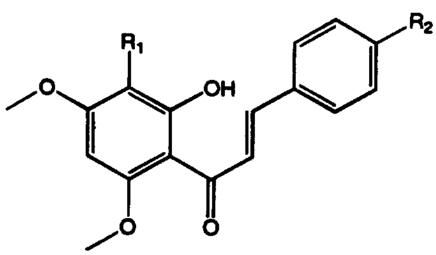
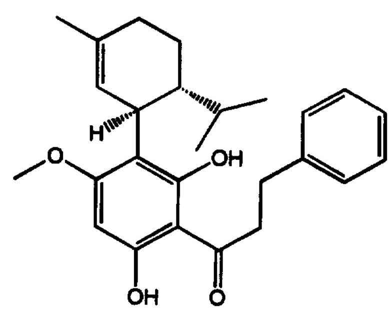


417 R_1=R_2=OH
419 R_1=OH; R_2=H



418 R_1=OH; R_2=H
420 R_1=H; R_2=OCH_3
421 R_1=R_2=H
422 R_1=H; R_2=OH
423 R_1=OCH_3; R_2=H



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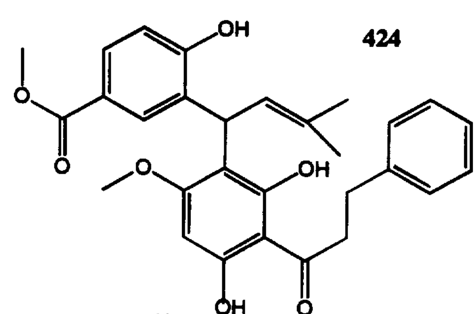

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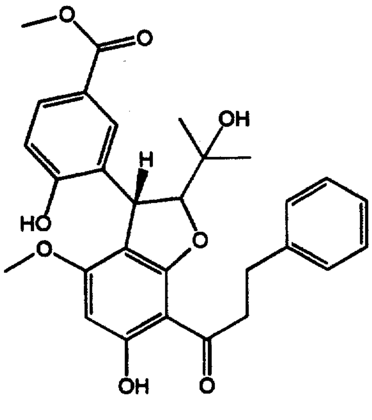

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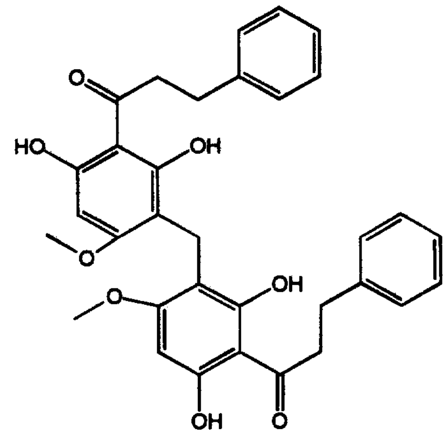

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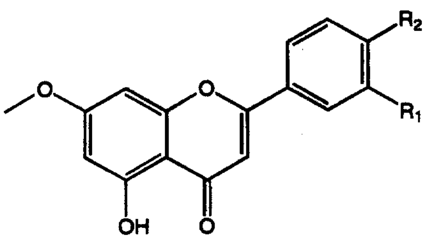
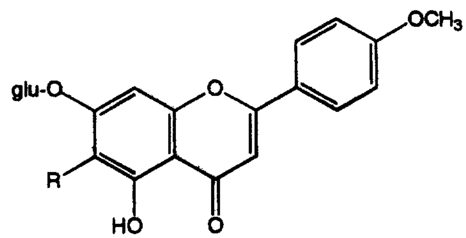
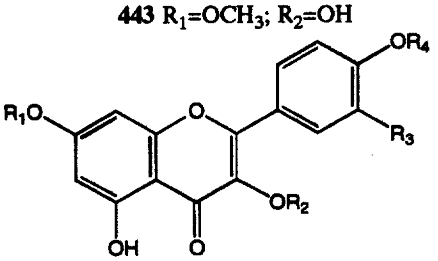


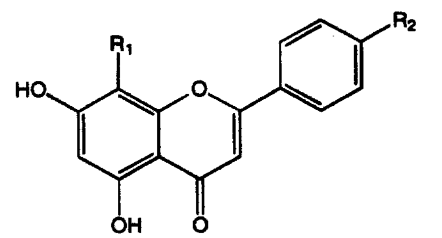
428 R_1=OH; R_2=OCH_3
429 R_1=H; R_2=OCH_3
432 R_1=R_2=OCH_3
442 R_1=R_2=H
443 R_1=OCH_3; R_2=OH

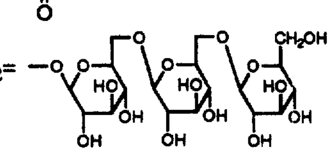


430 R=galactosyl
431 R=glucosyl



433 R_1=R_4=H; R_2=glucosyl; R_3=OH
434 R_1=H; R_2=rutinosyl; R_3=OH; R_4=CH_3
435 R_1=rhamnosyl; R_2=arabinosyl; R_3=R_4=H
436 R_1=R_3=R_4=H; R_2=glucosyl
438 R_1=R_4=H; R_2=galactosyl; R_3=OH
439 R_1=R_4=H; R_2=rhamnosyl; R_3=OH
440 R_1=R_4=H; R_2=rutinosyl; R_3=OH
441 R_1=CH_3; R_2=R_4=glucosyl; R_3=O-glucosyl



437 R_1=OH; R_2= 

444 R_1=OCH_3; R_2= O-glucosyl

FLAVONES

Only a few flavones have been isolated from *Piper* species. Most of the flavones isolated are tri- or tetraoxygenated (Table 10). Recently, two *C*-glycosides (**430** and **431**) have been isolated by us from *P. brachystachyum* [315]. This is the first report of the occurrence of flavone *C*-glycosides from the genus *Piper*.

Table 10. Flavones isolated from *Piper* species

Compound	Plant(s)	Reference(s)
7,4′-Dimethoxy-5,3′-dihydroxyflavone (**428**)	*P. auritum*	[238]
7,4′-Dimethoxy-5-hydroxyflavone (**429**)	*P. falconeri*	[11]
	P. khasiana	[46]
	P. manausense	[44]
	P. manii	[46]
	P. peepuloides	[46, 316]
	P. sylvaticum	[142]
6-*C*β-D-Galactopyranosylacacetin 7-*O*-glucoside (**430**)	*P. brachystachyum*	[315]
6-*C*-β-D-Glucopyranosylacacetin 7-*O*-glucoside (**431**)	*P. brachystachyum*	[315]
5-Hydroxy-7,3′,4′-trimethoxyflavone (**432**)	*P. peepuloides*	[46, 316]
	P. sylvaticum	[159]
Isoquercitrin (**433**)	*P. nigrum*	[317]
Isorhamnetin 3-*O*-β-D-rutinoside (**434**)	*P. nigrum*	[317]
Kaempferol 3-*O*-arabinoside-7-rhamnoside (**435**)	*P. nigrum*	[317]
Kaempferol 3-*O*-β-glucoside (**436**)	*P. nigrum*	[317]
Marginatoside (**437**)	*P. marginatum*	[314]
Quercetin 3-*O*-β-D-galactoside (**438**)	*P. nigrum*	[317]
Quercetin 3-*O*-β-D-rhamnoside (**439**)	*P. nigrum*	[317]
Quercetin 3-*O*-β-D-rutinoside (**440**)	*P. nigrum*	[317]
Rhamnetin *O*-triglucoside (**441**)	*P. nigrum*	[317]
Tectochrysin (**442**)	*P. falconeri*	[11]
	P. manii	[46]
	P. sylvaticum	[159]
Velutin (**443**)	*P. clarkii*	[219]
Vitexin (**444**)	*P. marginatum*	[314]

FLAVANONES

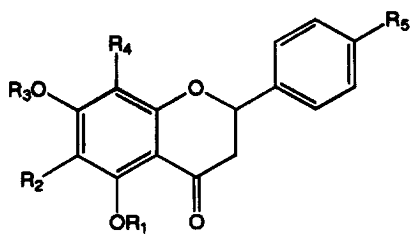
Flavanones which have been isolated so far from different *Piper* species (Table 11) are oxygenated only in the ring A, except sakuranetin (**450**) isolated from *P. aduncum* [309], which has a –OH group in the side phenyl ring.

Table 11. Flavanones from *Piper* species

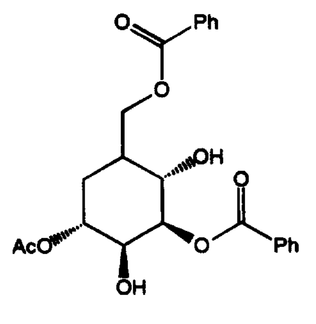
Compound	Plant(s)	Reference(s)
5,7-Dihydroxyflavanone (**445**)	*P. hostmannianum*	[261]
	P. steerni	[95]
6-Hydroxy-5,7-dimethoxyflavanone (**446**)	*P. hispidum*	[308]
8-Hydroxy-5,7-dimethoxyflavanone (**447**)	*P. hispidum*	[308]
5-Hydroxy-7-methoxy-6,8-dimethylflavanone (**448**)	*P. hostmannianum*	[261]

Table 11—*continued.*

Compound	Plant(s)	Reference(s)
Pinostrobin (**449**)	*P. aduncum*	[179, 180]
	P. fadyenii	[180]
	P. hispidum	[179, 180]
	P. steerni	[95]
Sakuranetin (**450**)	*P. aduncum*	[309]
5,7,8-Trimethoxyflavanone (**451**)	*P. hispidum*	[308]



445 R_1=R_2=R_3=R_4=R_5=H
446 R_1=R_3=CH_3; R_2=OH; R_4=R_5=H
447 R_1=R_3=CH_3; R_2=R_5=H; R_4=OH
448 R_1=R_5=H; R_2=R_3=R_4=CH_3
449 R_1=R_2=R_4=R_5=H; R_3=CH_3
450 R_1=R_2=R_4=H; R_3=CH_3; R_5=OH
451 R_1=R_3=CH_3; R_2=R_5=H; R_4=OCH_3



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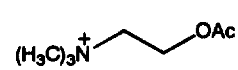

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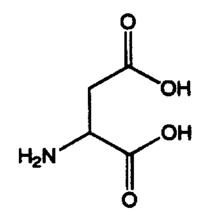

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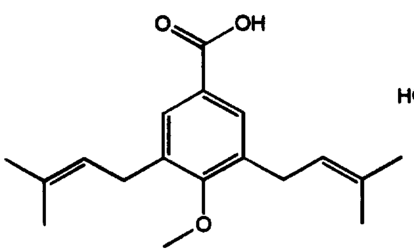

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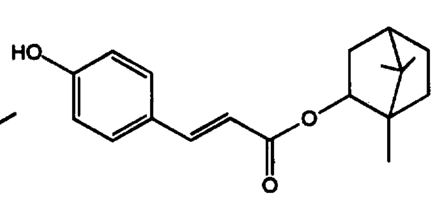

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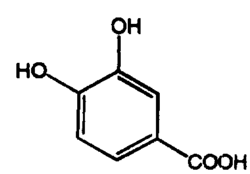

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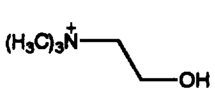

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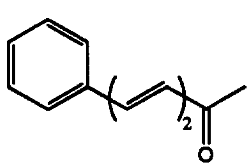

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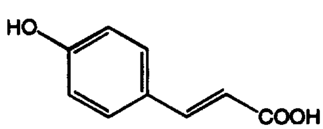

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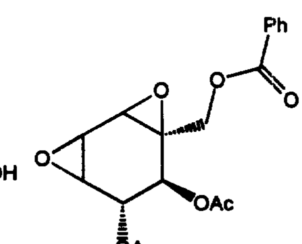

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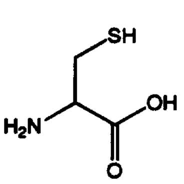

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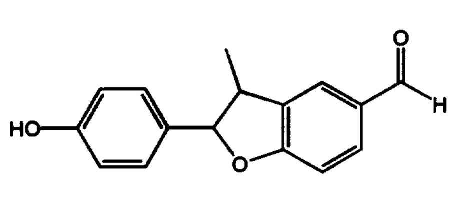

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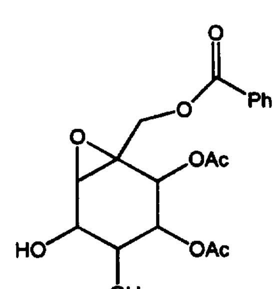


464

MISCELLANEOUS COMPOUNDS

Besides the above mentioned groups of compounds, several long chain alkanes, alcohols, acids, esters and oxygenated cyclohexanes, etc. have been isolated from *Piper* species (Table 12). Polyoxygenated cyclohexanes are rarely found in Nature and are reported to have tumour inhibitory, antileukemic and antibiotic activities [318]. In genus *Piper*, the first report of their occurrence was in *P. hookeri* which contains crotepoxide (**461**) [320] and pipoxide (**529**) [319]. Crotepoxide (**461**) has been reported to be an antitumour principle [320]. 3,4-Dimethoxycinnamic acid (**466**) and 3-(3,4-dimethoxyphenyl)propylamine (**467**) isolated from *P. arboricola* have been reported to show analgesic effects in mice [73]. The benzoic acid derivatives **455**, **484**, **485**, **497** and **504**, isolated from *P. aduncum* leaves have shown a significant antibacterial activity against *Bacillus subtilis*, *Micrococcus luteus* and *E. Coli* and compounds **455**, **484**, **485**, **500** and **504** have shown the molluscicidal activity against *Biomphalaria glabrata* [152].

Table 12. Miscellaneous compounds from *Piper* species

Compound	Plant(s)	Reference(s)
5-Acetoxypiperenol (**452**)	*P. clarkii*	[321]
Acetylcholine (**453**)	*P. nigrum*	[322]
γ-Aminobutyric acid ($NH_2(CH_2)_3COOH$)	*P. amalago*	[323]
D-asparatic acid (**454**)	*P. longum*	[324]
3,5-Bis(3-methyl-2-butenyl)-4-methoxybenzoic acid (**455**)	*P. aduncum*	[46, 152, 157, 179, 180]
	P. fadyenii	[180]
	P. hispidum	[179, 180]
Bornyl *p*-coumarate (**456**)	*P. ribesioides*	[96]
Caffeic acid (**457**)	*P. nigrum*	[325]
Capric acid ($CH_3(CH_2)_8COOH$)	*P. nigrum*	[326]
Cerotic acid ($CH_3(CH_2)_{24}COOH$)	*P. puberculum*	[203]
Choline (**458**)	*P. nigrum*	[322]
Cinnamylideneacetone (**459**)	*P. methysticum*	[327]
p-Coumaric acid (**460**)	*P. nigrum*	[325]
p- and *m*-Cresol	*P. nigrum*	[236]
Crotepoxide (**461**)	*P. attenuatum*	[205, 232, 328]
	P. brachystachyum	[155]
	P. clarkii	[272]
	P. futokadsura	[329]
	P. hancei	[217]
	P. hookeri	[320]
	P. interruptum	[113]
	P. polysyphorum	[330]
	P. ribesioides	[96]
	P. wallichii	[89]
	P. wightii	[48]
Cysteine (**462**)	*P. longum*	[324]
Decurrenal (**463**)	*P. decurrens*	[220]
3,4-Diacetoxy-5-benzoyloxymethyl-5,6-epoxycyclohexane-1,2-diol (**464**)	*P. wightii*	[48]
2-(3,4-Dihydroxyphenyl)ethanol (**465**)	*P. nigrum*	[71]
3,4-Dimethoxycinnamic acid (**466**)	*P. arboricola*	[73, 331]
3-(3,4-Dimethoxyphenyl)propylamine (**467**)	*P. arboricola*	[331]
2,2-Dimethyl-8-(3-methyl-2-butenyl)-2*H*-chromene-6-carboxylic acid (**468**)	*P. aduncum*	[252]
3-(2,5-Dimethoxy-3,4-methylenedioxyphenyl)-1,2-dihydroxypropane (**469**)	*P. sumatranum*	[160]

Table 12—*continued.*

Compound	Plant(s)	Reference(s)
3,5-Dimethoxytoluene (**470**)	*P. lenticellosum*	[331]
2,2-Dimethyl-6-carboxy-2*H*-1-chroman-4-one methyl ester (**471**)	*P. taboganum*	[276]
(+)-3,7-Dimethyl-3-hydroxy-4-(*p*-coumaroyloxy-1,6-octadiene (**472**)	*P. ribesioides*	[92]
Docosan-1-ol ($CH_3(CH_2)_{20}CH_2OH$)	*P. methysticum*	[237]
Dodecan-1-ol ($CH_3(CH_2)_{10}CH_2OH$)	*P. methysticum*	[237]
Dopamine (**473**)	*P. amalago*	[323]
Dotriacontanoic acid ($CH_3(CH_2)_{30}COOH$)	*P. betle*	[41]
n-Eicosane ($CH_3(CH_2)_{18}CH_3$)	*P. longum*	[257]
Eicosan-1-ol ($CH_3(CH_2)_{18}CH_2OH$)	*P. methysticum*	[237]
Ethyl piperonyl ketone (**474**)	*P. marginatum*	[182]
(5*Z*,6*Z*)-Fadyenolide (**475**)	*P. aduncum* *P. fadyenii* *P. hispidum*	[180] [180, 332] [180]
(5*E*,6*E*)-Fadyenolide (**476**)	*P. aduncum* *P. fadyenii* *P. hispidum*	[180] [180, 332] [180]
3-Farnesyl-4-hydroxybenzoic acid (**477**)	*P. auritum* *P. marginatum*	[238] [333]
3-Farnesyl-4-methoxybenzoic acid (**478**)	*P. marginatum*	[333]
Gallotannic acid (**479**)	*P. marginatum*	[334]
n-Heneicosane ($CH_3(CH_2)_{19}CH_3$)	*P. longum*	[257]
Hentriacontane ($CH_3(CH_2)_{29}CH_3$)	*P. betle* *P. nigrum*	[162] [127]
Hentriacontan-16-ol (**480**)	*P. nigrum*	[127]
Hentriacontan-16-one (**481**)	*P. nigrum*	[127]
n-Heptadecane ($CH_3(CH_2)_{15}CH_3$)	*P. longum*	[257]
Hexacosan-1-ol ($CH_3(CH_2)_{24}CH_2OH$)	*P. methysticum*	[237]
n-Hexadecane ($CH_3(CH_2)_{14}CH_3$)	*P. auritum* *P. longum*	[166] [257]
Hexadecan-1-ol ($CH_3(CH_2)_{14}CH_2OH$)	*P. methysticum*	[237]
4-[(5*E*)-*n*-Hexadecenyl]phenol (**482**)	*P. hispidum*	[161]
Hydrocinnamic acid (**483**)	*P. sarmentosum*	[275]
4-Hydroxy-3,5-bis(3-methyl-2-butenyl)benzoic acid (**484**)	*P. aduncum*	[152]
4-Hydroxy-3-(3-methyl-2-butenoyl)-5-(3-methyl-2-butenyl) benzoic acid (**485**)	*P. aduncum*	[152]
2-Hydroxy-4,5-methylenedioxypropiophenone (**486**)	*P. marginatum*	[165, 183]
Lauric acid ($CH_3(CH_2)_{10}COOH$)	*P. nigrum*	[326]
Linoleic acid (**487**)	*P. aurantiacum* *P. nigrum*	[267] [326]
Lutein (**488**)	*P. aduncum*	[309]
Maltose	*P. aurantiacum*	[174]
Malvalic acid (**489**)	*P. nigrum*	[326]
p-Methoxyacetophenone	*P. longum*	[257]

Table 12—*continued.*

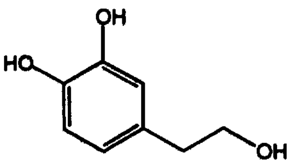
Compound	Plant(s)	Reference(s)
2-Methoxy-3-isobutylpyrazine (**490**)	*P. hancei*	[176]
2-Methoxy-4,5-methylenedioxybenzaldehyde (**491**)	*P. lenticellosum*	[335]
(*E*)-2-Methoxy-4,5-methylenedioxycinnamaldehyde (**492**)	*P. lenticellosum*	[335]
2-Methoxy-4,5-methylenedioxypropiophenone (**493**)	*P. marginatum*	[183]
Methyl 3,5-bis(3-methyl-2-butenyl)-4-methoxybenzoate (**494**)	*P. aduncum*	[152]
2-(3-Methyl-2-butenyl)-3,4,5-trimethoxyphenol (**495**)	*P. clarkii*	[219]
Methyl 2,2-dimethyl-2*H*-1-benzopyran-6-carboxylate (**496**)	*P. aduncum* *P. hostamannianum* *P. taboganum*	[262] [261] [276]
Methyl 3-(3,7-dimethyl-2,6-octadienyl)-4-methoxybenzoate (**497**)	*P. aduncum*	[152]
1-(1-Methylethyl)-4-methyl-3-cyclohexenyl-3,5-bis(3-methyl-2-butenyl)-4-hydroxybenzoate (**498**)	*P. aduncum*	[23]
1-(1-Methylethyl)-4-methyl-3-cyclohexenyl-3,5-bis(3-methyl-2-butenyl)-4-methoxybenzoate (**499**)	*P. aduncum*	[307]
Methyl 4-hydroxy-3,5-bis-(3-methyl-2-butenyl)-benzoate (**500**)	*P. aduncum*	[152]
Methyl 8-hydroxy-2,2-dimethyl-2*H*-chromene-6-carboxylate (**501**)	*P. aduncum*	[262]
Methyl 3-(6′hydroxy-3′,7′-dimethyl-2′,7′-octadienyl)-4-methoxybenzoate (**502**)	*P. aduncum*	[262]
Methyl 4-hydroxy-3-(2′-hydroxy-3′-methylbut-3′-enyl)-benzoate (**503**)	*P. aduncum* *P. hostmannianum*	[262] [261]
Methyl 4-hydroxy-3-(3-methyl-2-butenyl)benzoate (**504**)	*P. aduncum*	[152]
Methyl nodendroate (**505**)	*P. aduncum*	[309]
Methyl 2*E*,4*E*,6*E*-7-phenylheptatrienoate (**506**)	*P. ribesioides*	[88, 92]
Methyl piperate (**507**)	*P. hancei* *P. officinarum* *P. ribesioides* *P. schmidtii*	[50] [336] [92, 96] [53]
Methyl taboganate (**508**)	*P. taboganum*	[276]
(6*S*)-Methyl (2*E*)-6-hydroxy-2,6-dimethyl-2,7-octadienoate (**509**)	*P. aduncum*	[262]
Methyl (*E*)-2,4,5-trimethoxycinnamate (**510**)	*P. brachystachyum*	[38]
Methyl 3,4,5-trimethoxycinnamate (**511**)	*P. longum*	[125]
3,4-Methylenedioxycinnamaldehyde (**512**)	*P. nigrum*	[236]
3,4-Methylenedioxycinnamic acid (**513**)	*P. tuberculatum*	[338]
3,4-Methylenedioxycinnamylidene acetone (**514**)	*P. methysticum*	[327]
1-(3,4-Methylenedioxyphenyl)-(1*E*)-tetradecene (**515**)	*P. sarmentosum*	[93]
14-(3,4-Methylenedioxyphenyl)-tetradecan-2-ol (**516**)	*P. attenuatum*	[232]
3,4-Methylenedioxypropiophenone (**517**)	*P. marginatum*	[165, 183]
Myristic acid ($CH_3(CH_2)_{12}COOH$)	*P. nigrum*	[326]
Nonan-2-one ($CH_3(CH_2)_6CO{-}CH_3$)	*P. auritum*	[166]
n-Octadecane ($CH_3(CH_2)_{16}CH_3$)	*P. longum*	[257]
Octadecan-1-ol ($CH_3(CH_2)_{16}CH_2OH$)	*P. methysticum*	[237]
Oleic acid (**518**)	*P. nigrum*	[326]

Table 12—*continued.*

Compound	Plant(s)	Reference(s)
Oxalic acid ($(COOH)_2$)	*P. sarmentosum*	[339]
Palmitic acid ($CH_3(CH_2)_{14}COOH$)	*P. austrosinense*	[101]
	P. nigrum	[326]
	P. ribesioides	[92]
Pentatriacontane ($CH_3(CH_2)_{33}CH_3$)	*P. betle*	[162]
Phenylacetic acid ($C_6H_5CH_2COOH$)	*P. nigrum*	[246]
β-Phenylethanol ($C_6H_5CH_2CH_2OH$)	*P. longum*	[257]
1-Phenylethyl benzoate (**519**)	*P. hookeri*	[273]
Pipataline (**520**)	*P. brachystachyum*	[38]
	P. peepuloides	[97]
	P. sylvaticum	[159]
Piperchromanoic acid (**521**)	*P. auritum*	[238]
Piperchromenoic acid (**522**)	*P. auritum*	[238]
Piperoic acid (**523**)	*P. auritum*	[238]
Piperonal (**524**)	*P. marginatum*	[183]
	P. nigrum	[236]
Piperenol A (**525**)	*P. clarkii*	[321]
	P. cubeba	[321]
Piperenol A-triacetate (**526**)	*P. cubeba*	[233]
Piperenol B (**527**)	*P. cubeba*	[321]
Piperenol C (**528**)	*P. cubeba*	[233]
Pipoxide (**529**)	*P. attenuatum*	[205]
	P. hookeri	[319]
Pipoxide chlorohydrin (**530**)	*P. attenuatum*	[204, 205, 208]
	P. hookeri	[340]
Polysyphoside A (**531**)	*P. polysyphorum*	[330]
Polysyphoside B (**532**)	*P. polysyphorum*	[330]
Polysyphoside C (**533**)	*P. polysyphorum*	[330]
Prenylated hydroxybenzoic acids (**534–536**)	*P. demeraranum*	[71]
	P. saltuum	[337]
Senediol (**537**)	*P. ribesioides*	[96]
dl-Serine (**538**)	*P. longum*	[324]
Stearic acid ($CH_3(CH_2)_{16}COOH$)	*P. aurantiacum*	[267]
	P. betle	[41, 162]
	P. marginatum	[183]
	P. nigrum	[326]
	P. ribesioides	[92]
Sterculic acid (**539**)	*P. nigrum*	[326]
Sucrose	*P. aduncum*	[157]
n-Tetradecanol ($CH_3(CH_2)_{12}CH_2OH$)	*P. methysticum*	[237]
Tetratriacontanoic acid ($CH_3(CH_2)_{32}COOH$)	*P. attenuatum*	[205]
α-Tocopherol (**540**)	*P. aduncum*	[239]
	P. argyrophylum	[51]
n-Triacontane ($CH_3(CH_2)_{28}CH_3$)	*P. aurantiacum*	[267]
	P. brachystachyum	[155]
	P. hookeri	[273]
	P. longum	[123]
	P. sumatranum	[43, 104]

Table 12—*continued.*

Compound	Plant(s)	Reference(s)
n-Triacontanol ($CH_3(CH_2)_{28}CH_2OH$)	*P. betle* *P. brachystachyum* *P. hookeri* *P. nepalense*	[162] [155] [273] [91]
n-Tridecane ($CH_3(CH_2)_{11}CH_3$)	*P. marginatum*	[165]
Tritriacontane ($CH_3(CH_2)_{31}CH_3$)	*P. betle*	[41]
Tritriacontanol ($CH_3(CH_2)_{31}CH_2OH$)	*P. thomsoni*	[46]
2,4,5-Trimethoxybenzaldehyde (**541**)	*P. cubeba*	[200]
E-2,4,5-Trimethoxycinnamic acid (**542**)	*P. brachystachyum*	[38]
Z-2,4,5-Trimethoxycinnamic acid (**543**)	*P. brachystachyum*	[38]
3,4,5-Trimethoxycinnamic acid (**544**)	*P. tuberculatum*	[137]
3,4,5-Trimethoxydihydrocinnamic acid (**545**)	*P. retrofractum*	[138]
3-(2,4,5-Trimethoxyphenyl)-2-acetoxy-1-hydroxypropane (**546**)	*P. clusii*	[160]
3-(2,4,5-Trimethoxyphenyl)-1,2-diacetoxypropane (**547**)	*P. clusii*	[160]
3-(2,4,5-Trimethoxyphenyl)-1,2-dihydroxypropane (**548**)	*P. clusii*	[160]
3-(2,4,5-Trimethoxyphenyl)-2-hydroxy-1-methoxypropane (**549**)	*P. sumatranum*	[160]
L-Tyrosine (**550**)	*P. longum*	[324]
Vanillic acid (**551**)	*P. aurantiacum*	[229]
Vernolic acid (**552**)	*P. nigrum*	[326]
Villiramulin A (**553**)	*P. villiramulum*	[341]
Villiramulin B (**554**)	*P. villiramulum*	[341]
(+)-Zeylinol (**555**)	*P. cubeba*	[321]



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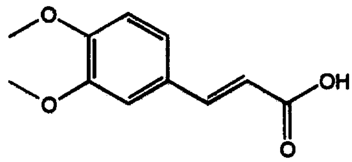

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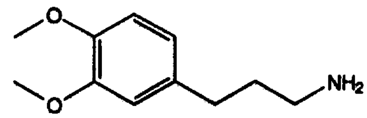

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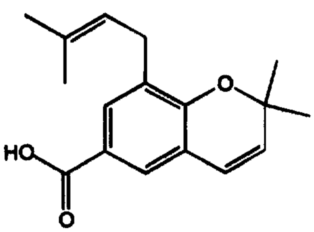

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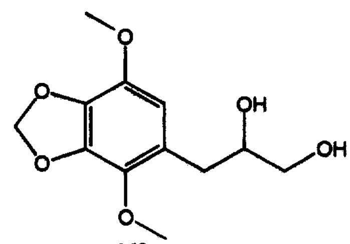

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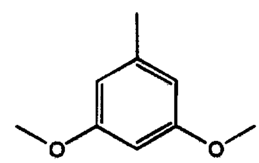

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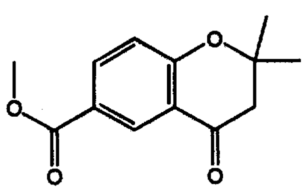

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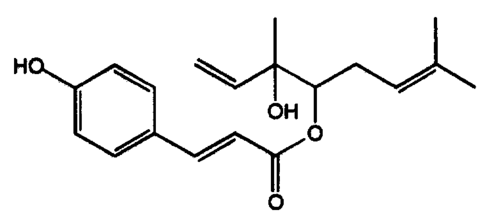

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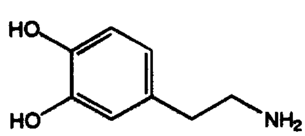

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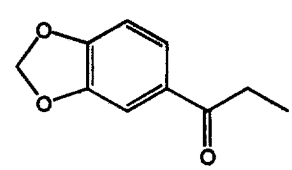

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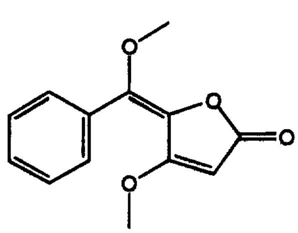

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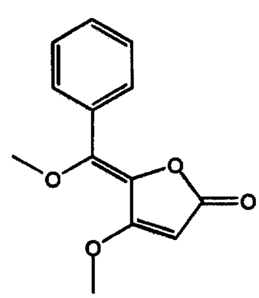

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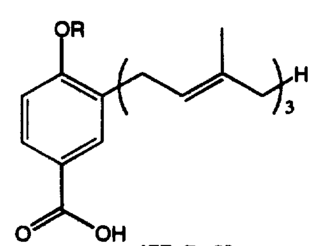

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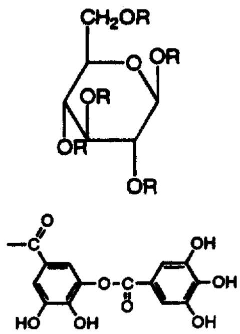
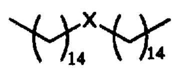
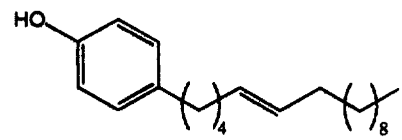
478 R=CH_3



479 R=



480 X= -CHOH
481 X= CO



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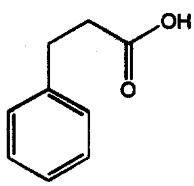

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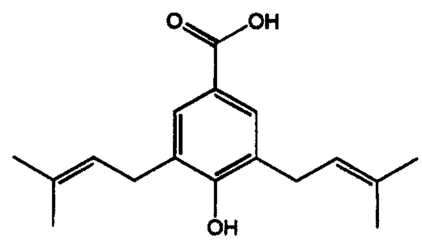

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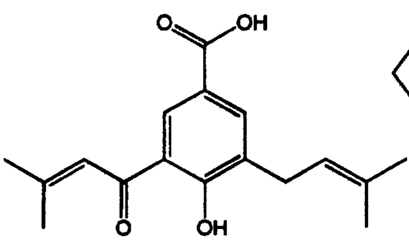

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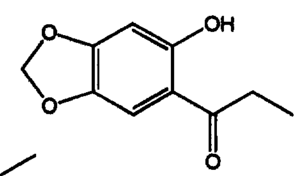

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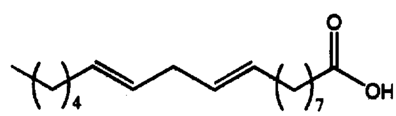

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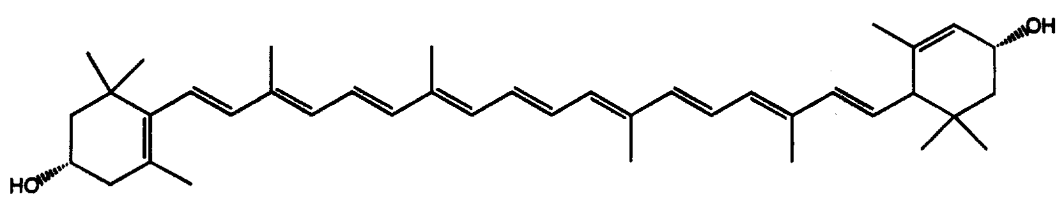

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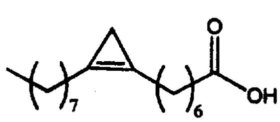

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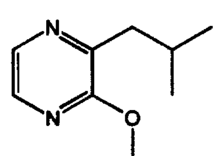

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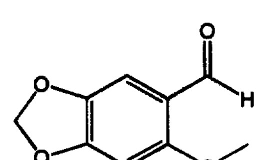

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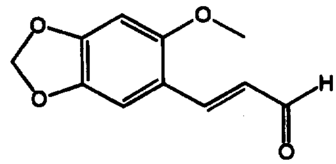

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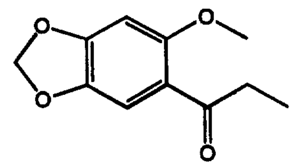

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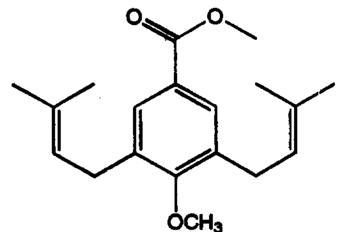

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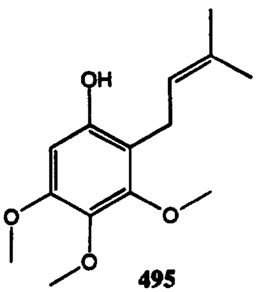

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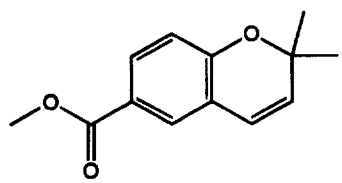

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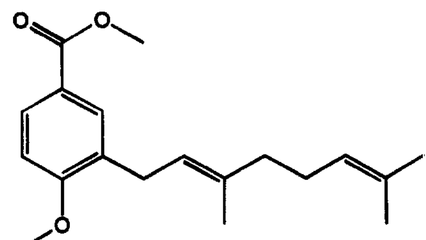

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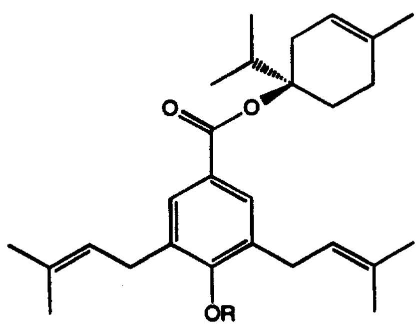
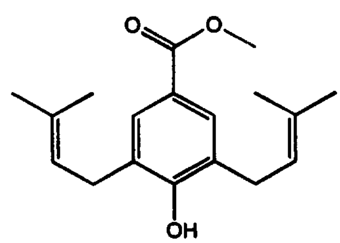


498 R=H
499 R=CH_3



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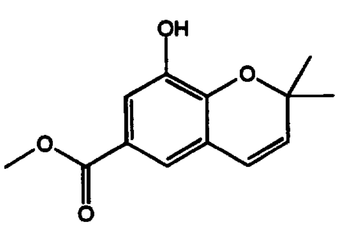

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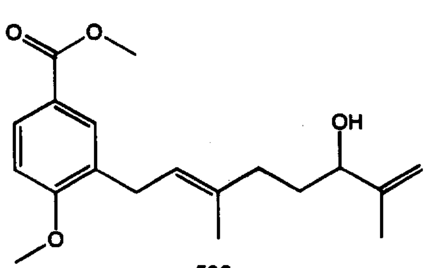

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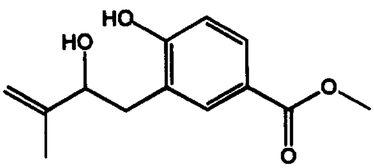

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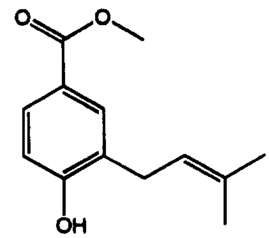

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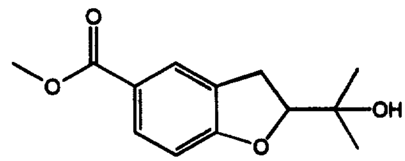

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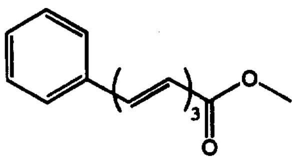

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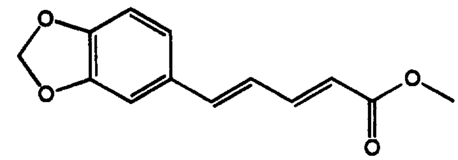

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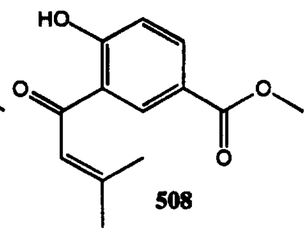

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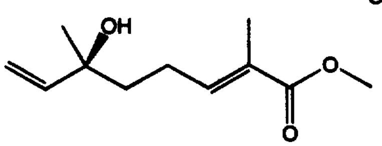

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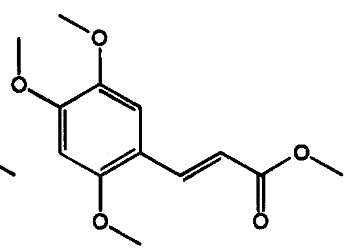

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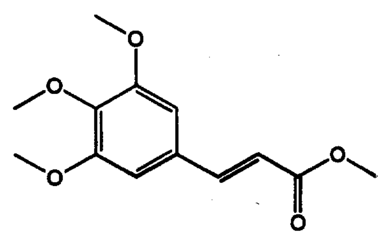

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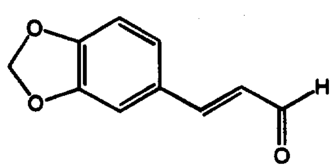

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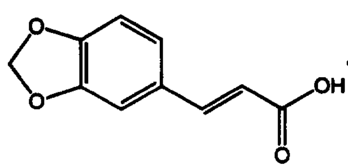

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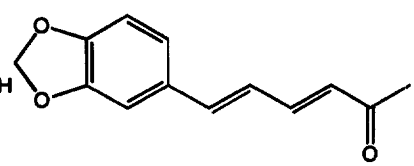

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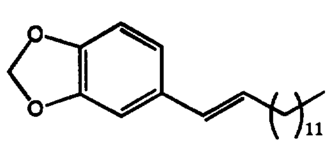

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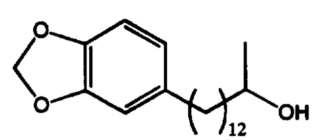

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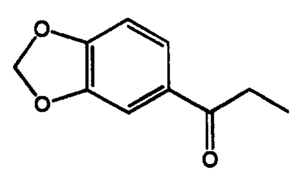

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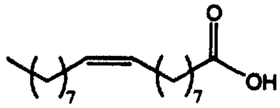

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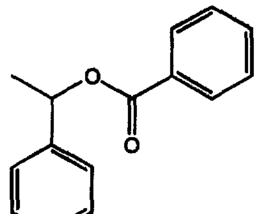

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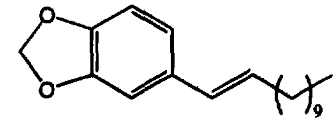

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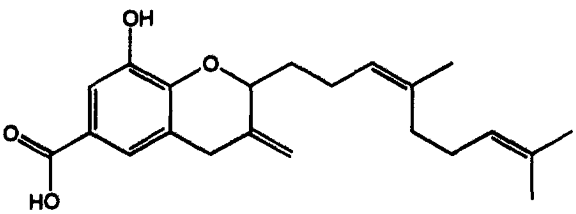

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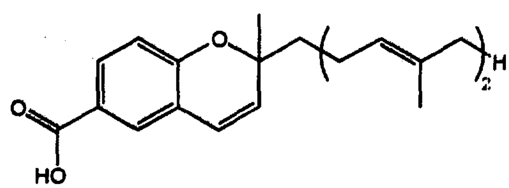

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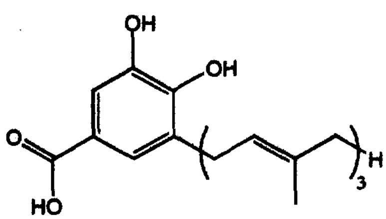

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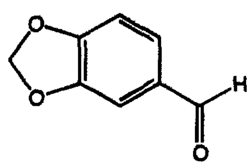

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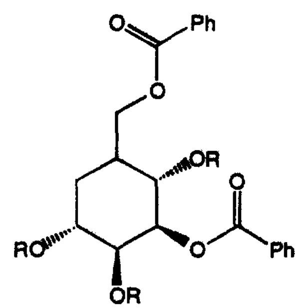
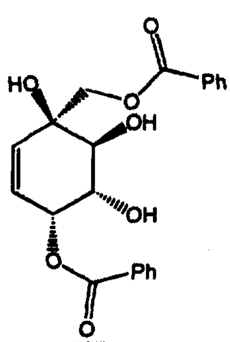


525 R=H
526 R=Ac



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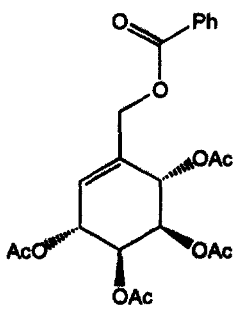

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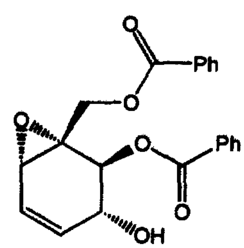

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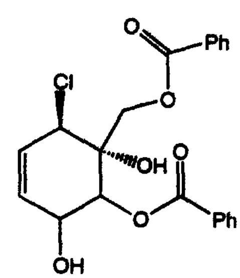

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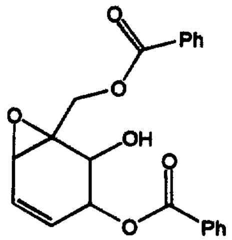

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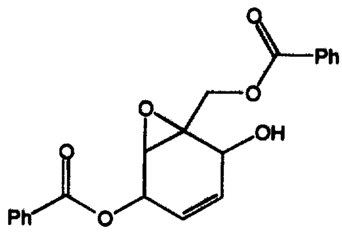

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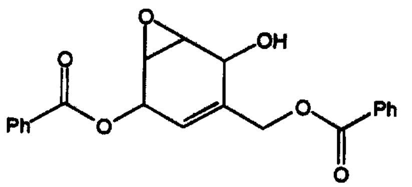

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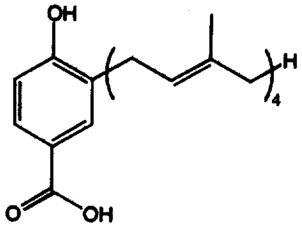

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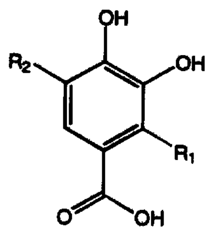
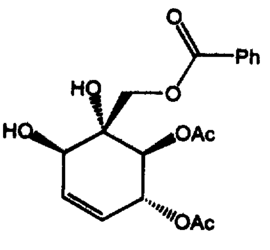


535 R_1=geranyl-geranyl; R_2=H
536 R_1=H; R_2=geranyl-geranyl



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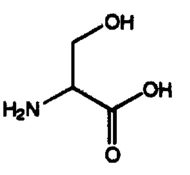

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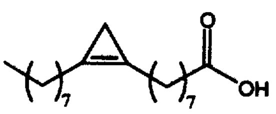

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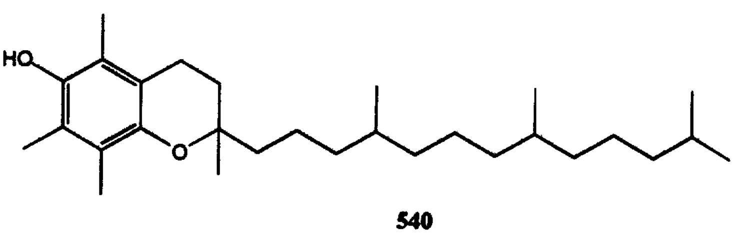

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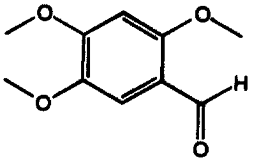

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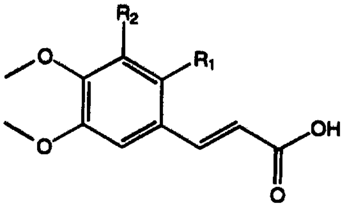
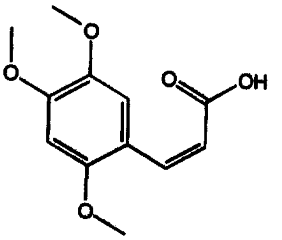


542 R_1=OCH_3; R_2=H
544 R_1=H; R_2=OCH_3



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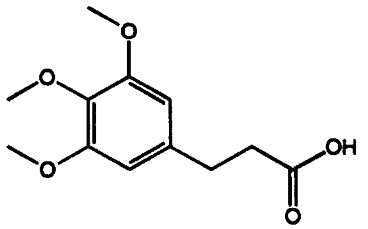

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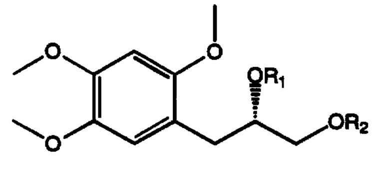
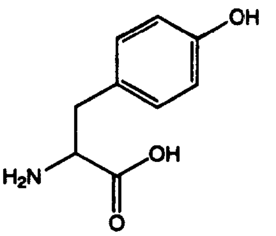


546 R_1=$COCH_3$; R_2=H
547 R_1=R_2=$COCH_3$
548 R_1=R_2=H
549 R_1=H; R_2=CH_3



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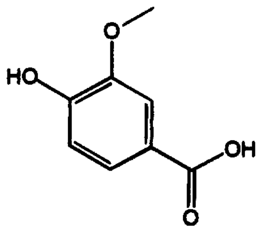

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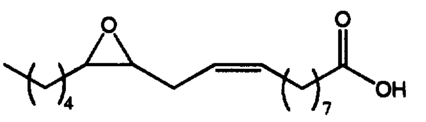

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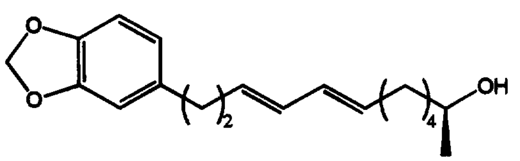

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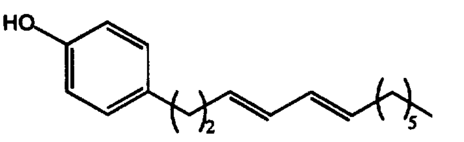

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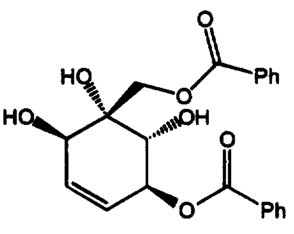

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CONCLUSION

The survey of phytochemical investigations of *Piper* species has revealed a wide variety of chemical constituents produced by them, important classes among others being alkaloids/amides, lignans, neolignans and terpenes. Out of a total of 592 different compounds isolated from *Piper* species, 145 are alkaloids/amides, 47 are lignans, 70 are neolignans and 89 are terpenes. These investigations were aimed to pinpoint the active components besides finding out new structural leads for future drugs. Taking into account the fact that there are 700 species belonging to this genus spread throughout the World and only 12% of them have been phytochemically investigated (only 84 species have been examined thus far), this genus still remains a potent one to work on. The investigations from the laboratories of the authors during the past five years have resulted in the isolation of 101 novel compounds from 16 *Piper* species; of these 14 compounds have shown different biological activities.

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REFERENCES

1. Kirtikar, K. R. and Basu, B. D., in *Indian Medicinal Plants*, Vol. III. 1933, 2128.
2. *The Wealth of India*, Vol. VIII, Raw Materials. CSIR, New Delhi, 1969, 83.
3. Geran, R. I., Greenberg, N. H., Macdonald, M. M., Schumacher, A. M. and Abbott, B. J., *Cancer Chemotherapy Reports*, 1972, **3**, 1 (*Chemical Abstracts*, **78**, 23825).
4. Asprey, G. F. and Thornton, P., in *Medicinal Plants of Jamaica*, 17. *West Indies Medicinal Journal*, Kingston, Jamaica, 1954.
5. Dominguez, X. A. and Alcorn, J. B., *Journal of Ethnopharmacology*, 1985, **13**, 139.
6. Kirtikar, K. R. and Basu, B. D., in *Indian Medicinal Plants*, Vol. III. 1933, 2130.
7. Jacobson, M. and Crosby, D. G., *Naturally Occurring Insecticides* (Marcel Dekker), 1971, **144**, 226.
8. Matsui, K. and Munakata, K., *Tetrahedron Letters*, 1975, 1905.
9. Irvine, F. R., in *Woody Plants of Ghana*. Oxford University Press, London, 1961, p. 40.
10. Concon, J. M., Newburg, D. S. and Swerczek, T. W., *Nutrition and Cancer*, 1979, **1**, 22.
11. Parmar, V. S., Sinha, R., Shakil, N. A., Tyagi, O. D., Boll, P. M. and Wengel, A., *Indian Journal of Chemistry*, 1993, **32B**, 392.
12. Olsen, C. E., Tyagi, O. D., Boll, P. M., Hussaini, F. A., Parmar, V. S., Sharma, N. K., Taneja, P. and Jain, S. C., *Phytochemistry*, 1993, **33**, 518.
13. Atal, C. K., Dhar, K. L. and Singh, J., *Lloydia*, 1975, **38**, 256.
14. Sengupta, S. and Ray, A. B., *Fitoterapia*, 1987, **58**, 147.
15. Tunmann, O., *Apotheker Zeitung*, 1918, **33**, 353 (*Chemical Abstracts*, **19**, 2940).
16. Lee, E. B., Shin, K. H. and Woo, W. S., *Archives of Pharmacology Research*, 1984, **7**, 127.
17. Miyakado, M., Nakayama, I., Yoshioka, H. and Nakatani, N., *Agriculture and Biological Chemistry*, 1979, **43**, 1609.
18. Miyakado, M., Nakayama, I. and Yoshioka, H., *Agriculture and Biological Chemistry*, 1980, **44**, 1701.
19. Kiuchi, F., Nakamura, N., Tsuda, Y., Kaoru, K. and Yoshimura, H., *Chemical and Pharmaceutical Bulletin*, 1988, **36**, 2452.
20. Oizumi, Y., Kajiwara, A., Shoji, N. and Takemoto, T., *Chemical Abstracts*, 1988, **108**, P68970.
21. Shoji, N., Umeyama, A., Saito, N., Takemoto, T., Kajiwara, A. and Ohizumi, Y., *Journal of Pharmacological Science*, 1986, **75**, 118.
22. Boll, P. M., Hansen, J. and Simonsen, O., *Tetrahedron*, 1984, **40**, 171.
23. Orjala, J., Wright, A. D., Rali, T. and Sticher, O., *Natural Products Letters*, 1993, **2**, 231.
24. Baldwyn, T., Ivan, A. M. and Lambert, M., *Insect Science Applications*, 1992, **13**, 705 (*Chemical Abstracts*, **121**, 3248).
25. Singh, S. K., Prasad, A. K., Olsen, C. E., Jha, A., Jain, S. C., Parmar, V. S. and Wengel, J., *Phytochemistry*, 1996, **43**, 1355.
26. Cortes, D., Hocquemiller, R., Leboeuf, M., Cave, A. and Moretti, C., *Journal of Natural Products*, 1986, **49**, 878.
27. Pachaly, P., Adnan, A. Z. and Will, G., *Planta Medica*, 1992, **52**, 184.
28. Achenbach, H. and Schwinn, A., *Phytochemistry*, 1995, **38**, 1037.
29. Maxwell, A. and Rampersad, D., *Journal of Natural Products*, 1989, **52**, 891.
30. Maxwell, A. and Rampersad, D., *Journal of Natural Products*, 1989, **52**, 411.
31. Desai, S. J., Chaturvedi, R. N., Badheka, L. P. and Mulchandani, N. B., *Indian Journal of Chemistry*, 1989, **28B**, 775.
32. Desai, S. J., Prabhu, B. R. and Mulchandani, N. B., *Phytochemistry*, 1988, **27**, 1511.
33. Banerji, A. and Ray, R., *Indian Journal of Chemistry*, 1981, **20B**, 597.
34. Banerji, A. and Das, R., *Indian Journal of Chemistry*, 1975, **13B**, 1234.
35. Banerji, A. and Ray, R., *Phytochemistry*, 1981, **20**, 2217.
36. Banerji, A., Ray, R., Siddhanta, A. and Pal, S., *Indian Journal of Chemistry*, 1979, **17B**, 538.
37. Banerji, A., Ray, R., Bandyopadhyay, D., Basu, S., Maiti, S., Bose, A. and Majumdar, P. L., *Indian Journal of Chemistry*, 1993, **32B**, 776.
38. Koul, S. K., Taneja, S. C., Aggarwal, V. K. and Dhar, K. L., *Phytochemistry*, 1988, **27**, 3523.
39. Miyakado, M., Nakayama, I., Ohno, N. and Yoshioka, H., *Current Themes in Tropical Science*, 1983, **2**, 369 (*Chemical Abstracts*, **99**, 189749).
40. Banerji, A. and Das, C., *Phytochemistry*, 1989, **28**, 3039.
41. Parmar, V. S., Jain, S. C., Sharma, N. K., Talwar, S., Rajwanshi, V. K. and Olsen, C. E., *Indian Journal of Chemistry* (under publication).
42. Haensel, R., Leuschke, A. and Gomez-Pompa, A., *Llyodia*, 1975, **38**, 529.
43. Dutta, C. P., Banerjee, N. and Roy, D. N., *Phytochemistry*, 1975, **14**, 2090.
44. DeDiaz, A. M. P., Diaz, P. P. and Nathan, P. J., *Revista Colombiana de Quimica*, 1990, **19**, 63 (*Chemical Abstracts*, **116**, 148269).

45. Jaggy, H. and Achenbach, H., *Planta Medica*, 1992, **58**, 111.
46. Parmar, V. S., Jain, S. C., Gupta, S., Rajwanshi, V. K., Kumar, R., Jain, R., Tyagi, O. D., Olsen, C. E. and Wengel, J., *Phytochemistry* (under publication).
47. Haensel, R. and Leuschke, A., *Phytochemistry*, 1976, **15**, 1323.
48. Boll, P. M., Prasad, A. K., Tyagi, O. D., Wengel, J., Olsen, C. E., Kumar, N., Bisht, K. S. and Parmar, V. S., *Recueil des Travaux Chimiques des Pays-Bas*, 1996, **115**, 9.
49. Pena, O. L. A. and de Diaz, A. M. P., *Revista Colombiana de Quimica*, 1995, **24**, 17 (*Chemical Abstracts*, **123**, 310301).
50. Narui, T., Takeuchi, M., Ishii, R., Ishida, T. and Okuyama, T., *Natural Medicine*, 1995, **49**, 438 (*Chemical Abstracts*, **124**, 198152).
51. Gupta, S., Jha, A., Prasad, A. K., Rajwanshi, V. K., Jain, S. C., Parmar, V. S., Olsen, C. E. and Wengel, J., *Phytochemistry* (under publication).
52. Takahashi, S., Kurabayashi, M., Ogiso, A. and Mishima, H., *Chemical and Pharmaceutical Bulletin*, 1969, **17**, 1225.
53. Tyagi, O. D., Prasad, A. K., Wengel, J., Boll, P. M., Olsen, C. E., Parmar, V. S., Sharma, N. K., Jha, A. and Bisht, K. S., *Acta Chemica Scandanavica*, 1995, **49**, 142.
54. Dhar, K. L., Shah, S., Prabhakar, A. and Sharma, R. L., *Fitoterapia*, 1995, **66**, 390.
55. Joshi, B. S., Viswanathan, N., Gawad, D. H., Balakrishnan, V. and Von Philipsborn, W., *Helvetia Chimica Acta*, 1975, **58**, 2295.
56. Joshi, B. S., Viswanathan, N., Gawad, D. H., Balakrishnan, V., Von Philipsborn, W. and Quick, A., *Experientia*, 1975, **31**, 880.
57. Connolly, J. D., Deans, R. and Haque, M. E., *Fitoterapia*, 1995, **66**, 188.
58. Oizumi, Y., Kajiwara, A., Shoji, N. and Takemoto, T., *Chemical Abstracts*, 1988, **108**, 11232.
59. Dwuma-Badu, D., Ayim, J. S. K., Dabra, T. T., ElSohly, H. N., Knapp, J. E., Slatkin, D. J. and Schiff Jr., P. L., *Llyodia*, 1976, **39**, 60.
60. Mensah, I. A., Torto, F. G., Dimonyeka, C. I., Baxter, I. and Sanders, J. K. M., *Phytochemistry*, 1977, **16**, 757.
61. Loder, J. W., Moorhouse, A. and Russell, G. B., *Australian Journal of Chemistry*, 1969, **22**, 1531.
62. Achenbach, H., Fietz, W., Woerth, J., Waibel, R. and Portecop, J., *Planta Medica*, 1986, 12.
63. Dwuma-Badu, D., Ayim, J. S. K., Dabra, T. T., ElSohly, H. N., ElSohly, M. A., Knapp, J. E., Slatkin, D. J. and Schiff, P. L., *Phytochemistry*, 1976, **15**, 822.
64. Tabuneng, W., Bando, H. and Amiya, T., *Chemical and Pharmaceutical Bulletin*, 1983, **31**, 3562.
65. Bernard, C. B., Krishnamurthy, H. G., Chanret, D., Durst, T., Philogene, B. J. R., Sanchez-Vindas, P., Hasbun, C., Poveda, L., San Roman, L. and Arnason, J. T., *Journal of Chemical Ecology*, 1995, **21**, 801 (*Chemical Abstracts*, **123**, 79538).
66. Kijjoa, A., Giesebrecht, A. M. and Gottlieb, O. R., *Planta Medica*, 1982, **44**, 188.
67. Maxwell, A. and Rampersad, D., *Journal of Natural Products*, 1991, **54**, 1150.
68. Sondengam, B. L., Kimbu, S. F. and Connolly, J. D., *Phytochemistry*, 1977, **16**, 1121.
69. Sondengam, B. L. and Kimbu, S. F., *Tetrahedron Letters*, 1977, 69.
70. Okogun, J. I., Sondengam, B. L. and Kimbu, S. F., *Phytochemistry*, 1977, **16**, 1295.
71. Bandyopadhyay, C., Narayan, V. S. and Variyar, P. S., *Journal of Agriculture and Food Chemistry*, 1990, **38**, 1696.
72. Duh, C. Y., Wu, Y. C. and Wang, S. K., *Phytochemistry*, 1990, **29**, 2689.
73. He, Q., Lu, Y., Cai, D., Cui, Y., Lai, J. and Wang, H., *Zhongcaoyao*, 1981, **12**, 433 (*Chemical Abstracts*, **97**, 11684).
74. Kikuzaki, H., Kawabata, M., Ishida, E., Akazawa, Y., Takei, Y. and Nakatani, N., *Bioscience, Biotechnology and Biochemistry*, 1993, **57**, 1329.
75. Seeram, N. P., Lewis, P. A., Jacobs, H., McLean, S., Reynolds, W. F., Tay, L. L. and Yu, M., *Journal of Natural Products*, 1996, **59**, 436.
76. Inatani, R., Nakatani, N. and Fuwa, H. S., *Agricultural and Biological Chemistry*, 1981, **45**, 667.
77. Gupta, O. P., Gupta, S. C., Dhar, K. L. and Atal, C. K., *Indian Journal of Chemistry*, 1976, **14B**, 912.
78. De Brauwere, J. and Verzele, M., *Bulletin de la Sociéte Chimique de Belgique*, 1975, **84**, 167 (*Chemical Abstracts*, **83**, 25073).
79. Li, S., Han, G., Arison, B. H. and Chang, M. N., *Yaoxue Xuebao*, 1987, **22**, 196 (*Chemical Abstracts*, **107**, 20765).
80. Dasgupta, S. and Ray, H. B., *Indian Journal of Chemistry*, 1979, **17B**, 538.
81. Okogun, J. I. and Ekung, D. E. U., *Journal of the Chemical Society, Perkin Transactions I*, 1974, **19**, 2195.
82. Gbewonyo, W. S. K. and Candy, D. J., *Journal of Chromatography*, 1992, **607**, 105.
83. Su, H. C. F. and Horvat, R., *Journal of Agriculture and Food Chemistry*, 1981, **29**, 115.

84. Nakatani, N. and Inatani, R., *Agriculture and Biological Chemistry*, 1981, **45**, 1473.
85. Gupta, O. P., Dhar, K. L. and Atal, C. K., *Phytochemistry*, 1976, **15**, 425.
86. Ahn, J. W., Lee, C. O., Kim, E. J., Zee, O. P. and Kim, H. J., *Bulletin of the Korean Chemical Society*, 1992, **13**, 338 (*Chemical Abstracts*, **117**, 230116).
87. Banerji, A., Banerji, J., Chaterjee, A. and Shoolery, J. N., *Indian Journal of Chemistry*, 1980, **19B**, 346.
88. Gbewonyo, W. S. K. and Candy, D. J., *Toxicon*, 1992, **30**, 1037 (*Chemical Abstracts*, **117**, 208934).
89. Han, G. Q., Wei, L. H., Li, C. L., Qiao, L., Jia, Y. Z. and Zheng, Q. T., *Acta Pharmaceutica Sinica*, 1989, **24**, 438 (*Chemical Abstracts*, **112**, 91459).
90. Dhar, K. L. and Atal, C. K., *Indian Journal of Chemistry*, 1967, **5**, 588.
91. Gupta, O. P., Atal, C. K. and Gaind, K. N., *Phytochemistry*, 1972, **11**, 2646.
92. Kijjoa, A., Pinto, M. M. M., Tantisewie, B. and Herz, W., *Planta Medica*, 1989, **55**, 193.
93. Likhitwitayawuid, K., Ruangrungsi, N., Lange, G. L. and Decicco, C. P., *Tetrahedron*, 1987, **43**, 3689.
94. Banerjee, A., Rej, R. N. And Ghosh, P. C., *Experientia*, 1974, **30**, 223.
95. Posso, O. R., Diaz, P. P., deDiaz, A. M. P., *Revista Colombiana de Quimica*, 1994, **23**, 53 (*Chemical Abstracts*, **122**, 286624).
96. Ruangrungsi, N., Prathanturarug, S., Lange, G. S. and Organ, M. G., *Phytochemistry*, 1992, **31**, 2397.
97. Dhar, K. L. and Raina, M. L., *Planta Medica*, 1973, **23**, 295.
98. Hou, C. Y., Zhang, J. Q., Zhang, Y. M. and Liu, Y. L., *Yaoxue Xuebao*, 1989, **24**, 789 (*Chemical Abstracts*, **112**, 73874).
99. Raina, M. L., Dhar, K. L. and Atal, C. K., *Planta Medica*, 1976, **30**, 198.
100. Gupta, O. P., Gupta, S. C., Dhar, K. L. and Atal, C. K., *Phytochemistry*, 1977, **16**, 1436.
101. Liu, H., Xiao, P. and Han, G., *Tianran Chanwu Yanjiu Yu Kaifa*, 1995, **7**, 20 (*Chemical Abstracts*, **123**, 280894).
102. Banerji, A. and Nandi, G., *Indian Journal of Chemistry*, 1988, **27B**, 163.
103. Tackie, A. N., Dwuma-Badu, D., Ayim, J. S. K., ElSohly, H. N., Knapp, J. E., Slatkin, D. J. and Schiff Jr., P. L., *Phytochemistry*, 1975, **14**, 1888.
104. Loder, J. W. and Nearn, R. H., *Phytochemistry*, 1972, **11**, 2645.
105. Achenbach, H. and Karl, W., *Chemisch Bericht*, 1970, **103**, 2535.
106. Sehgal, C. K., Kachroo, P. L., Sharma, R. L., Taneja, S. C., Dhar, K. L. and Atal, C. K., *Phytochemistry*, 1979, **18**, 1865.
107. Dominguez, X. A., Verde, J. S., Sucar, S. and Trevino, R., *Phytochemistry*, 1986, **25**, 239.
108. Gupta, O. P., Gupta, S. C., Dhar, K. L. and Atal, C. K., *Phytochemistry*, 1978, **17**, 601.
109. Duh, C. Y., Wu, Y. C. and Wang, S. K., *Journal of Natural Products*, 1990, **53**, 1575.
110. Shah, S., Kalla, A. K. and Dhar, K. L., *Phytochemistry*, 1986, **25**, 1997.
111. Ahn, J. W., Ahn, M. J., Zee, O. P., Kim, E. J., Lee, S. G., Kim, H. J. and Kubo, I., *Phytochemistry*, 1992, **31**, 3609.
112. Pring, B. G., *Journal of the Chemical Society*, *Perkin Transactions I*, 1982, 1493.
113. Thebpatiphat, S., Pengprecha, S. and Ternai, B., *Journal of the Science Society of Thailand*, 1988, **14**, 225 (*Chemical Abstracts*, **110**, 111803).
114. Rao, J. M., Subrahamanyam, K. and Rao, K. V. J., *Current Science*, 1974, **43**, 76.
115. Singh, J., Potdar, M. A., Atal, C. K. and Dhar, K. L., *Phytochemistry*, 1974, **13**, 677.
116. Singh, J., Santani, D. D. and Dhar, K. L., *Phytochemistry*, 1976, **15**, 2018.
117. Nakatani, N., Miyakado, M., Nakayama, I. and Hirai, H., *Chemical Abstracts*, 1980, **92**, 55352.
118. Miyakado, M., *Nippin Noyaku Gakkaishi*, 1986, **11**, 483 (*Chemical Abstracts*, **106**, 62876).
119. Glasl, H., Borup-Grochtmann, I. and Wagner, H., *Deutsche Apothekar Zeitung*, 1976, **116**, 1638 (*Chemical Abstracts*, **86**, 78710).
120. Mishra, S. S. and Tewari, J. P., *Journal of Pharmaceutical Science*, 1964, **53**, 1423.
121. Patra, A. and Ghosh, A., *Phytochemistry*, 1974, **13**, 2889.
122. Hadorn, H. and Jungkunz, R., *Pharmaceutica Acta. Helvetia*, 1951, **26**, 25.
123. Atal, C. K. and Banga, S. S., *Indian Journal of Pharmacology*, 1962, **24**, 105 (*Chemical Abstracts*, **59**, 15329).
124. Chatterjee, A. and Dutta, C. P., *Science Culture*, 1963, **29**, 568 (*Chemical Abstracts*, **62**, 16314).
125. Dutta, C. P., Bannerjee, N., Sil, A. K. and Roy, D. N., *Indian Journal of Chemistry*, 1977, **15B**, 583.
126. Spring, F. S. and Stark, J., *Journal of the Chemical Society*, 1950, 1177.
127. Singh, J., Vasudevan, K. and Rai, R. S., *Journal of the Indian Chemical Society*, 1976, **53**, 1162.
128. Mahanta, P. K., Ghanim, A. and Gopinath, K. W., *Journal of Pharmaceutical Science*, 1974, **63**, 1160.
129. Banerji, J. and Dhara, K. P., *Phytochemistry*, 1974, **13**, 2327.
130. Wu, Q., Feng, Y. and Yang, J., *Chinese Chemical Letters*, 1994, **5**, 203 (*Chemical Abstracts*, **121**, 104122).
131. Chatterjee, A. and Dutta, C. P., *Tetrahedron*, 1967, **23**, 1769.
132. Chatterjee, A. and Dutta, C. P., *Tetrahedron Letters*, 1966, 1797.

133. Smith, R. M., *Tetrahedron*, 1979, **35**, 437.
134. Smith, R. M., *Phytochemistry*, 1983, **22**, 1055.
135. Desai, S. J., Chaturvedi, R. and Mulchandani, N. B., *Journal of Natural Products*, 1990, **53**, 496.
136. Govindachari, T. R., Jadhav, S. J., Joshi, B. S., Kamat, V. N., Mohammed, P. A., Parthasarathy, P. C., Patankar, S. J., Prakash, D., Ran, D. F. and Viswanathan, N. V., *Indian Journal of Chemistry*, 1969, **7**, 308.
137. Filho, R. B., De Souza, M. P. and Mattos, M. E. O., *Phytochemistry*, 1981, **20**, 345.
138. Banerji, A., Bandyopadhyay, D., Sarkar, M., Siddhanta, A. K., Pal, S. C., Ghosh, S., Abraham, K. and Shoolery, J. N., *Phytochemistry*, 1985, **24**, 279.
139. Ahmad, F., Jamil, S. and Read, R. W., *Phytochemistry*, 1995, **40**, 1163.
140. Banerji, A. and Pal, S. C., *Phytochemistry*, 1982, **21**, 1321.
141. Dutta, C. P. and Banerjee, N., *Indian Journal of Chemistry*, 1976, **14B**, 389.
142. Banerji, A. and Ghosh, P. C., *Tetrahedron*, 1973, **29**, 977.
143. Singh, J., Dhar, K. L. and Atal, C. K., *Tetrahedron Letters*, 1971, 2119.
144. Singh, J., Dhar, K. L. and Atal, C. K., *Tetrahedron Letters*, 1969, 4975.
145. Sondengam, B. L., Kimbu, S. F., Njimi, T., Okogun, J. I. and Ekong, D. E. U., *Tetrahedron Letters*, 1977, 367.
146. Mensah, I. A., Torto, F. G. and Baxter, I., *Tetrahedron Letters*, 1976, 3049.
147. Mensah, I. A., Torto, F. G., Torto, B. and Achenbach, H., *Planta Medica*, 1981, **41**, 200.
148. Evans, P. H., Bowers, W. S., Funk, E. J. and Evangeline, J., *Journal of Agriculture and Food Chemistry*, 1984, **32**, 1254.
149. Dubey, P. and Tripathi, S. C., *Zeitschrift, Pflanzenkrankh Pflanzenschutz*, 1987, **94**, 235 (*Chemical Abstracts*, **107**, 194937).
150. Nair, M. G. and Burke, B. A., *Journal of Agriculture and Food Chemistry*, 1990, **38**, 1093.
151. Masuda, T., Inazumi, A., Yamada, Y., Padolina, W. G., Kikuzaki, H. and Nakatani, N., *Phytochemistry*, 1991, **30**, 3227.
152. Orjala, J., Erdelmeier, C. A. J., Wright, A. D., Rali, T. and Sticher, O., *Planta Medica*, 1993, **59**, 546.
153. Rimando, A. M., Han, B. H., Park, J. H. and Cantoria, M. C., *Archives of Pharmacological Research*, 1986, **9**, 93 (*Chemical Abstracts*, **106**, 38203).
154. Alencar, J. W., Craveiro, A. A. and Matos, F. J. A., *Journal of Natural Products*, 1984, **47**, 890.
155. Singh, J. and Atal, C. K., *Indian Journal of Pharmacology*, 1969, **31**, 129 (*Chemical Abstracts*, **72**, 107813).
156. Tyagi, O. D., Jensen, S., Boll, P. M., Sharma, N. K., Bisht, K. S. and Parmar, V. S., *Phytochemistry*, 1993, **32**, 445.
157. Macedo, J. C. B. and Oviedo, S. G., *Boletin de la Sociedad Quimica del Peru*, 1987, **53**, 228 (*Chemical Abstracts*, **109**, 98636).
158. Likhituitayawuid, K., Ruangrengsi, N., Lange, G. L. and Deccico, C. P., *Journal of the Science Society of Thailand*, 1988, **14**, 77 (*Chemical Abstracts*, **109**, 226710).
159. Malhotra, S., Koul, S. K., Taneja, S. C., Pushpangadan, P. and Dhar, K. L., *Phytochemistry*, 1990, **29**, 2733.
160. Koul, S. K., Taneja, S. C., Malhotra, S. and Dhar, K. L. *Phytochemistry*, 1993, **32**, 478.
161. Avella, E., Diaz, P. P. and Aura, M. P., *Planta Medica*, 1994, **60**, 195.
162. Deshpande, S. M., Upadhyay, R. R. and Singh, R. P., *Current Science*, 1970, **39**, 372.
163. Smith, R. M. and Kassim, H., *New Zealand Journal of Science*, 1979, **22**, 127 (*Chemical Abstracts*, **91**, 189836).
164. Ekundayo, O., Laakso, I., Adegbola, R. M., Oguntimein, B., Sofowora, A. and Hiltunen, R., *Journal of Agriculture and Food Chemistry*, 1988, **36**, 880.
165. Ramos, L. S., Da Silva, M. L., Luz, A. I. R., Zoghbi, M. G. B. and Maia, J. G. S., *Journal of Natural Products*, 1986, **49**, 712.
166. Gupta, M. P., Arias, T. D., Williams, N. H., Bos, R. and Tattje, D. H. E., *Journal of Natural Products*, 1985, **48**, 330.
167. Diaz, D., Pedro, P. and Dorado, J. V., *Revista Latinoamericana de Quimica*, 1986, **17**, 58 (*Chemical Abstracts*, **105**, 75982).
168. Hwang, L. S., Wang, C. K., Sheu, M. J. and Kao, L. S., *Chemical Abstracts*, 1993, **118**, 58461.
169. DeAlencar, R., Delima, R. A., Correa, R. G. C., Gottlieb, O. R., DaSilva, M. L., Marx, M. C., Maia, J. G. S., Magalhaes, M. T. and Assumpcao, R. M. V., *Anais da Academia Brasileira de Ciencias*, 1974, **44S**, 312 (*Chemical Abstracts*, **83**, 120650).
170. Gurib-Fakim, A., *Planta Medica*, 1994, **60**, 376.
171. Gottlieb, O. R., Koketsu, M., Magalhaes, M. T., Maia, J. G. S., Mendes, P. H., Da Rocha, A. I., Da Silva, M. L. and Wilberg, V. C., *Acta Amazonica*, 1981, **11**, 143 (*Chemical Abstracts*, **96**, 3657).

172. Foungbe, S., Tillequin, F., Paris, M., Jacquemin, H. and Paris, R. R., *Annales Pharmaceuliques Francaises*, 1976, **34**, 339 (*Chemical Abstracts*, **86**, 86142).
173. Sethi, S. C. and Aggarwal, J. S., *Journal of Science and Independent Research*, 1956, **15B**, 34 (*Chemical Abstracts*, **51**, 15031).
174. Falkiner, M., Loder, J. W., Russell, G. B. and Shelton, M., *Australian Journal of Chemistry*, 1972, **25**, 2417.
175. Opdyke, D. L. J., *Food and Cosmetics Toxicology*, 1976, **14**, 729 (*Chemical Abstracts*, **86**, 161020).
176. Wang, L., Wu, R., Wan, F. and Song, Z., *Developments in Food Science* (Flavours Fragrances), 1988, **18**, 295 (*Chemical Abstracts*, **109**, 176067).
177. Russell, G. F., *Chemical Abstracts*, 1970, **72**, 118448.
178. Terhune, S. J., Hogg, J. W., Bromstein, A. C. and Lawrence, B. M., *Canadian Journal of Chemistry*, 1975, **53**, 3285.
179. Burke, B. and Nair, M., *Phytochemistry*, 1986, **25**, 1427.
180. Nair, M. G., Mansingh, A. P. and Burke, B. A., *Agricultural and Biological Chemistry*, 1986, **50**, 3053.
181. Maia, J. G., Goeldi, M. P. E., Green, B. C. L. and Milchard, M. J., *Perfume and Flavour*, 1993, **18**, 19 (*Chemical Abstracts*, **119**, 79766).
182. Leao da Silva, M., Maia, J. G. S., Mourao, J. C., Pedreira, G., Marx, M. C., Gottlieb, O. R. and Megalhaes, M. T., *Acta Amazonica*, 1973, **3**, 41 (*Chemical Abstracts*, **82**, 135732).
183. Diaz, A. M. P. and Gottlieb, O. R., *Planta Medica*, 1979, **35**, 190.
184. MacRae, W. D. and Towers, G. H. N., *Phytochemistry*, 1984, **23**, 1207.
185. Haensel, R. and Pelter, A., *Archives of Pharmacology*, 1969, **302**, 940 (*Chemical Abstracts*, **72**, 121393).
186. Haensel, R., Leuckert, C. and Schultz, G., *Zeitschrift für Naturforschung, B*, 1966, **21**, 530 (*Chemical Abstracts*, **65**, 14101).
187. Koul, S, K., Taneja, S. C., Dhar, K. L. and Atal, C. K., *Phytochemistry*, 1984, **23**, 2099.
188. Prasad, A. K., Tyagi, O. D., Wengel, J., Boll, P. M., Olsen, C. E., Sharma, N. K., Bisht, K. S., Gupta, S. and Parmar, V. S., *Tetrahedron*, 1994, **50**, 2231; corrigendum *Tetrahedron*, **50**, 6721.
189. Koul, S. K., Taneja, S. C., Dhar, K. L. and Atal, C. K., *Phytochemistry*, 1983, **22**, 999.
190. Prabhu, B. R. and Mulchandani, N. B., *Phytochemistry*, 1985, **24**, 329.
191. Vanegas, M. T., Cabezas, F. F., Gottlieb, O. R., Sandoval, L. and Montero, E., *Revue Latinoamericano Quimica*, 1984, **14**, 139 (*Chemical Abstracts*, **100**, 188783).
192. Sumathykutty, M. A. and Rao, J. M., *Indian Journal of Chemistry*, 1988, **27B**, 388.
193. Koul, S. K., Taneja, S. C., Pushpangadan, P. and Dhar, K. L., *Phytochemistry*, 1988, **27**, 1479.
194. Abdallah, O. M. and Ibraham, Z. Z., *Pharmazie*, 1996, **51**, 187.
195. Badheka, L. P., Prabhu, B. R. and Mulchandani, N. B., *Phytochemistry*, 1986, **25**, 487.
196. Atal, C. K., Dhar, K. L. and Pelter, A., *Journal of the Chemical Society C*, 1967, 2228.
197. Banerji, A. and Das, R., *Indian Journal of Chemistry*, 1977, **15B**, 495.
198. Dwuma-Badu, D., Ayim, J. S. K. and Dabra, T. T., *Llyodia*, 1975, **38**, 343.
199. Prasad, A. K., Tyagi, O. D., Wengel, J., Boll, P. M., Olsen, C. E., Gupta, S., Sharma, N. K., Bisht, K. S. and Parmar, V. S., *Tetrahedron*, 1994, **50**, 10579.
200. Prasad, A. K., Tyagi, O. D., Wengel, J., Boll, P. M., Olsen, C. E., Bisht, K. S., Singh, A., Sarangi, A., Kumar, R., Jain, S. C. and Parmar, V. S., *Phytochemistry*, 1995, **39**, 655.
201. Badheka, L. P., Prabhu, B. R. and Mulchandani, N. B., *Phytochemistry*, 1987, **26**, 2033.
202. Chin, Z., Yu, P. and Xu, P., *Zhongguo Zhongyao Zazhi*, 1993, **18**, 292 (*Chemical Abstracts*, **119**, 17385).
203. Zhang, S., Liu, X., Zhang, L. and Wan, D., *Tianran Chanwu Yanjiu Yu Kaifa*, 1992, **4**, 1 (*Chemical Abstracts*, **118**, 109472).
204. Sumathykutty, M. A. and Rao, J. M., *Phytochemistry*, 1991, **30**, 2075.
205. Sumathykutty, M. A. and Rao, J. M., *Fitoterapia*, 1993, **64**, 281.
206. Ma, Y., Han, G. Q., Li, C. L., Cheng, J. R., Arison, B. H. and Hwang, S. B., *Acta Pharmaceutica Sinica*, 1991, **26**, 345 (*Chemical Abstracts*, **115**, 247446).
207. Atal, C. K., Girotra, R. N. and Dhar, K. L., *Indian Journal of Chemistry*, 1966, **4**, 252.
208. Jensen, S., Hansen, J. and Boll, P. M., *Phytochemistry*, 1993, **33**, 523.
209. Banerji, A. and Pal, S. C., *Journal of Natural Products*, 1982, **45**, 672.
210. Banerji, A., Sarkar, M., Ghosal, T., Pal, S. C. and Shoolery, J. N., *Tetrahedron*, 1984, **40**, 5047.
211. Shen, T. Y., Hwang, S. B., Chang, M. N., Doebber, T. W., Lam, M. H. T., Wu, M. S., Wang, X., Han, G. and Li, R., *Proceedings of the National Academy of Science of the U.S.A.*, 1985, **82**, 672 (*Chemical Abstracts*, **102**, 160196).
212. Chang, M. N., Han, G. Q., Arison, B. H., Springer, J. P., Hwang, S. B. and Shen, T. Y., *Phytochemistry*, 1985, **24**, 2079.
213. Ma, Y., Han, C. Q. and Liu, Z. J., *Yaoxue Xuebao*, 1993, **28**, 207 (*Chemical Abstracts*, **119**, 108622).
214. Joshi, N., Garg, H. S. and Bhakuni, D. S., *Journal of Natural Products*, 1990, **53**, 479.

215. Zhang, S. X., Chen, Ke., Liu, X. J., Zhang, D. C., Tao-Wiedmann, T. W., Leu, S. L., McPhail, A. T. and Lee, K. H., *Journal of Natural Products*, 1995, **58**, 540.
216. Ma, Y., Han, G., He, C. and Zheng, Q., *Chinese Chemical Letters*, 1991, **2**, 623 (*Chemical Abstracts*, **116**, 191078).
217. Green, T. P., Galinis, D. L. and Wiemer, D. F., *Phytochemistry*, 1991, **30**, 1649.
218. Tyagi, O. D., Wengel, J., Prasad, A. K., Boll, P. M., Olsen, C. E., Pati, H. N., Bisht, K. S. and Parmar, V. S., *Acta Chemica Scandinavica*, 1994, **48**, 1007.
219. Jensen, S., Olsen, C. E., Tyagi, O. D., Boll, P. M., Hussaini, F. A., Gupta, S., Bisht, K. S. and Parmar, V. S., *Phytochemistry*, 1994, **36**, 789.
220. Chauret, D. C., Bernard, C. B., Arnason, J. T., Durst, T., Krishnamurthy, H. G., Sanchez-Vindas, P., Moreno, N., San Roman, L. and Poveda, L., *Journal of Natural Products*, 1996, **59**, 152.
221. Han, G., Li, S., Li, C., Springer, J. P., Hwang, S. B. and Chang, M. N., *Yaoxue Xuebao*, 1986, **21**, 361 (*Chemical Abstracts*, **105**, 111982).
222. Green, T. P. and Wiemer, D. F., *Phytochemistry*, 1991, **30**, 3759.
223. Takahashi, S., *Phytochemistry*, 1969, **8**, 321.
224. Ogiso, A., Kurabayashi, M., Mishima, H. and Woods, M. C., *Tetrahedron Letters*, 1968, 2003.
225. Matsui, K. and Munakata, K., *Tetrahedron Letters*, 1976, 4371.
226. Takahashi, S. and Ogiso, A., *Chemical and Pharmaceutical Bulletin*, 1970, **18**, 100.
227. Li, S. and Han, G., *Zhiwu Xuebao*, 1987, **29**, 293 (*Chemical Abstracts*, **108**, 3404).
228. Pradhan, P., Desai, S. J., Badheka, L. P. and Banerji, A., *Natural Products Letters*, 1994, **4**, 35.
229. Han, G., Dai, P., Zu, L., Wang, S. and Zheng, Q., *Chinese Chemical Letters*, 1992, **3**, 521 (*Chemical Abstracts*, **118**, 77031).
230. Ma, Y., Han, G., Jiang, T. and Yang, X., *Chinese Chemical Letters*, 1992, **3**, 635 (*Chemical Abstracts*, **118**, 56138).
231. Shen, T. Y., Hwang, S. B., Chang, M. N., Doebber, T. W., Lam, M. H., Wu, M. S. and Wang, X., *International Journal of Tissue Reactions*, 1985, **7**, 339 (*Chemical Abstracts*, **104**, 15049).
232. Kumar, N., Malhotra, S., Prasad, A. K., Jain, S. C., Parmar, V. S., Olsen, C. E., Haworth, O. W., Errington, W. and Wengel, J., *Phytochemistry* (under publication).
233. Koul, J. L., Koul, S. K., Taneja, S. C. and Dhar, K. L., *Phytochemistry*, 1996, **41**, 1097.
234. Ma, Y. and Han, G., *Zhiwu Xuebao*, 1993, **35**, 687 (*Chemical Abstracts*, **121**, 5191).
235. Matsui, K. S. and Munakata, K., *Agriculture and Biological Chemistry*, 1976, **40**, 1113 (*Chemical Abstracts*, **86**, 29547).
236. Kollmannsberger, H., Nitz, S. and Drawert, F., *Zeitschrift für Lebens-mittel-Untersuchung und Forschung*, 1992, **194**, 545 (*Chemical Abstracts*, **118**, 123262).
237. Graeza, L. and Ruff, P., *Archives of Pharmacology*, 1986, **319**, 475 (*Chemical Abstracts*, **104**, 230306).
238. Ampofo, S. A., Roussis, V. and Wiemer, D. F., *Phytochemistry*, 1987, **26**, 2367.
239. Orjala, J., Wright, A. D., Erdelmeier, C. A. J., Sticher, O. and Rali, T., *Helvetia Chimica Acta*, 1993, **76**, 1481.
240. Muller, C. J., *Chemical Abstracts*, 1967, **68**, 75718.
241. Poser, G. L. V., Rorig, L. R., Hensigues, A. T., Lamaty, G., Menut, C. and Bessiere, J. M., *Journal of Essential Oil Research*, 1994, **6**, 337 (*Chemical Abstracts*, **121**, 163661).
242. Terhune, S. J., Hogg, J. W. and Lawrence, B. M., *Phytochemistry*, 1974, **13**, 1183.
243. Sumathykutty, M. A., and Rao, J. M., *Indian Perfume*, 1990, **34**, 182 (*Chemical Abstracts*, **114**, 171012).
244. Anderson, N. H., Syrdai, D. D., Lawrence, B. M., Terhune, S. J. and Hogg, J. W., *Phytochemistry*, 1973, **12**, 827.
245. Pino, J., Rodriguez-Feo, G., Borges, P. and Rosado, A., *Nahrung*, 1990, **34**, 555 (*Chemical Abstracts*, **115**, 27893).
246. Hewitt, E. J., Konigbacher, K. S. and Ritter, J. J., *Journal of Agriculture and Food Chemistry*, 1957, **51**, 53.
247. Ciccio, J. F., *Ingenieria de Ciencias Quimica*, 1995, **1S**, 39 (*Chemical Abstracts*, **124**, 185121).
248. Machado, S. M. F., Militao, J. S. L. T., Facundo, V. A., Ribeiro, A., Morais, S. M. and Machado, M. I. L., *Journal of Essential Oil Research*, 1994, **6**, 643 (*Chemical Abstracts*, **122**, 101640).
249. Ikeda, R., Stanley, W. L., Vannier, S. H. and Spitler, E. M., *Journal of Food Science*, 1962, **27**, 455.
250. Chen, T. B., Green, T. P. and Wiemer, D. F., *Tetrahedron Letters*, 1992, 5673.
251. Rao, B. S., Shintre, V. P. and Simonsen, J. L., *Journal of the Society of the Chemical Industry*, 1928, **47**, 92T (*Chemical Abstracts*, **22**, 2028).
252. Diaz, D., Pedro, P., Maldonado, E. and Ospina, E., *Revue Latinoamericano Quimica*, 1984, **15**, 136 (*Chemical Abstracts*, **102**, 84248).
253. Wrolstad, R. E. and Jennings, W. G., *Journal of Food Science*, 1965, **30**, 274 (*Chemical Abstracts*, **63**, 1156).

254. Thappa, R. K., Vashist, V. N., Singh, J. and Sharma, R. K., *Current Science*, 1970, **39**, 182.
255. Rajdan, R. K. and Bhattacharya, S. C., *Current Science*, 1952, **21**, 68.
256. Shankaracharya, N. B., Rao, L. J., Nagalakshmi, S. and Puranaik, J., *PAFAI Journal*, 1995, **17**, 33 (*Chemical Abstracts*, **124**, 230423).
257. Handa, K. L., Sharma, M. L. and Nigam, M. C., *Parfuemerie und Kosmetik*, 1963, **44**, 233 (*Chemical Abstracts*, **60**, 9095).
258. Muller, C. J., Creveling, R. K. and Jennings, W. G., *Journal of Agriculture and Food Chemistry*, 1968, **16**, 113.
259. Yoshihara, K., Ohta, Y., Sakai, T. and Hirose, Y., *Tetrahedron Letters*, 1969, 2263.
260. Achenbach, H., Gross, J. and Portecop, J., *Planta Medica*, 1984, **50**, 528.
261. Diaz, D. P. P., Tiberio, A. C. and Joseph-Nathan, P., *Phytochemistry*, 1987, **26**, 809.
262. Orjala, J., Erdelmeier, C. A. J., Wright, A. D., Rali, T. and Sticher, O., *Phytochemistry*, 1993, **34**, 813.
263. Sharma, M. L., Rawat, A. K. S., Balasubrahmanyam, V. R. and Singh, A., *Indian Perfume*, 1983, **27**, 91 (*Chemical Abstracts*, **101**, 11993).
264. Russel, G. F., Murray, W. J., Muller, C. J. and Jennings, W. G., *Journal of Agriculture and Food Chemistry*, 1968, **16**, 1047.
265. Calle, A. J. and Farreira, A. S., *Revista Colombiana de Ciencias Quimica Farmaceuticas*, 1973, **2**, 81 (*Chemical Abstracts*, **82**, 76989).
266. Saeed, S. A., Farnaz, S., Simjee, R. U. and Malik, A., *Biochemistry Society Transactions*, 1993, **21**, 462 (*Chemical Abstracts*, **119**, 195314).
267. Singh, J., Santani, D. D. and Pani, R., *Indian Journal of Pharmaceuticals*, 1976, **38**, 58 (*Chemical Abstracts*, **85**, 74911).
268. Banerji, A. and Das, R., *Indian Journal of Chemistry*, 1977, **15B**, 395.
269. Achenbach, H., Calle, A. D., Maussa, D. and Poveda, C., *Revista Mexicana de Ciencias Farmaceuticas*, 1984, **14**, 2 (*Chemical Abstracts*, **100**, 188774).
270. Ganguly, P. and Choudhury, M., *Indian Agriculture*, 1975, **19**, 199.
271. Khosla, R. L. and Dixit, S. N., *Indian Journal of Pharmaceuticals*, 1971, **33**, 118.
272. Boll, P. M., Hald, M., Parmar, V. S., Tyagi, O. D., Bisht, K. S., Sharma, N. K. and Hansen, S., *Phytochemistry*, 1992, **31**, 1035.
273. Singh, J. and Atal, C. K., *Phytochemistry*, 1969, **8**, 2253.
274. Haensel, R., Pelter, A., Schulz, J. and Hille, C., *Chemisch Bericht*, 1976, **109**, 1617.
275. Niamsa, N. and Chantrapromma, K., *Warasan Songkhla Nakkharin*, 1983, **5**, 151 (*Chemical Abstracts*, **101**, 167142).
276. Roussis, V., Ampofo, S. A. and Wiemer, D. F., *Phytochemistry*, 1990, **29**, 1787.
277. Atal, C. K. and Banga, S. S., *Current Science*, 1963, **32**, 354.
278. Meyer, H. J., *Archives of the Institute of Pharmacodynamic Therapy*, 1962, **138**, 505 (*Chemical Abstracts*, **58**, 1827).
279. Kretzschemar, R. and Meyer, H. J., *Archives of the Institute of Pharmacodynamic Therapy*, 1969, **177**, 261 (*Chemical Abstracts*, **72**, 30057).
280. Meyer, H. J. and Kretzschmar, R., *Klinische Wochenschrift*, 1966, **44**, 902 (*Chemical Abstracts*, **65**, 12750).
281. Kretzschmar, R., Meyer, H. J. and Teschendorf, H. J., *Experientia*, 1970, **26**, 283.
282. Meyer, H. J. and May, H. U. *Klinik Woehschrung*, 1964, **42**, 407 (*Chemical Abstracts*, **61**, 5448).
283. Young, R. L., Hylin, J. W., Plucknett, D. L., Kawano, Y. and Nakayama, R. T., *Phytochemistry*, 1966, **5**, 795.
284. Haensel, R., Wiess, D. and Schmidt, B., *Planta Medica*, 1966, **14**, 1.
285. Smith, R. M., Thakrar, H., Arowolo, T. A. and Shafi, A. A., *Journal of Chromatography*, 1984, **283**, 303.
286. Haensel, R. and Lazar, J., *Deutsch Apothecarie Zeitung*, 1985, **125**, 2056 (*Chemical Abstracts*, **104**, 74869).
287. Kretzschmar, R. and Meyer, H. J., *Archives of the Institute of Pharmacodynamic Therapy*, 1968, **175**, 1 (*Chemical Abstracts*, **70**, 18689).
288. Meyer, H. J. and Meyer-Burg, J., *Archives of the Institute of Pharmacodynamic Therapy*, 1964, **148**, 97 (*Chemical Abstracts*, **60**, 15013).
289. Meyer, H. J., Oberdorff, A. and Seifen, E., *Archives of Experimental Pathology and Pharmacology*, 1960, **238**, 124 (*Chemical Abstracts*, **54**, 13433).
290. Engel, P. and Nowacki, W., *Verhandlung Schweizerisch Naturforschung Gesellschaft*, 1971, **151**, 153 (*Chemical Abstracts*, **77**, 106428).
291. Achenbach, H. and Wilmann, G., *Tetrahedron Letters*, 1970, 3259.
292. Borsche, W. and Rath, A., *Bericht*, 1921, **54B**, 2229 (*Chemical Abstracts*, **16**, 1085).
293. Haensel, R. and Beiersdorff, H. U., *Naturwissenschaften*, 1958, **45**, 573 (*Chemical Abstracts*, **53**, 11758).
294. Achenbach, H., Karl, W. and Regel, W., *Chemisch Bericht*, 1972, **105**, 2182.
295. Haensel, R. and Schulz, J., *Archives of Pharmaceuticals*, 1982, **315**, 147 (*Chemical Abstracts*, **97**, 20669).

296. Som, U. K., Dutta, C. P., Sarkar, G. M. and Banerjee, R. D., *National Academy of Science Letters*, 1985, **8**, 109 (*Chemical Abstracts*, **103**, 210886).
297. Haensel, R., Beer, C. and Schulz, J., *Chemisch Bericht*, 1973, **106**, 3119.
298. Haensel, R. and Klaproth, L., *Archives of Pharmaceuticals*, 1966, **299**, 503 (*Chemical Abstracts*, **65**, 15154).
299. Som, U. K., Dutta, S. and Dutta, C. P., *National Academy of Science Letters*, 1983, **6**, 271 (*Chemical Abstracts*, **101**, 226686).
300. Di Renzo, N., *Farmaco Edizione Pratica*, 1972, **27**, 318 (*Chemical Abstracts*, **77**, 66235).
301. Achenbach, H., Karl, W. and Smith, S., *Chemisch Bericht*, 1971, **104**, 2688.
302. Haensel, R. and Schulz, J., *Archives of Pharmaceuticals*, 1982, **315**, 148 (*Chemical Abstracts*, **97**, 20669).
303. Pelter, A. and Haensel, R., *Zeitschrift für Naturforschung*, 1972, **27**, 1186 (*Chemical Abstracts*, **78**, 40397).
304. Bradeczek, H., Hecht, H. J. and Reinhardt, R., *Journal of Crystallography and Molecular Structure*, 1978, **7**, 147.
305. Haensel, R. and Pelter, A., *Phytochemistry*, 1971, **10**, 1627.
306. Haensel, R., Schulz, J., Pelter, A. and Ayoub, M. T., *Zeitschrift für Naturforschung*, 1979, **34B**, 1576 (*Chemical Abstracts*, **93**, 114205).
307. Orjala, J., Wright, A. D., Behrends, H., Folkers, G. and Sticher, O., *Journal of Natural Products*, 1994, **57**, 18.
308. Vieira, P. C., DeAlvarenga, M. A., Gottlieb, O. R. and Gottlieb, H. E., *Planta Medica*, 1980, **39**, 153.
309. Dutta, C. P. and Som, U. K., *Journal of the Indian Chemical Society*, 1978, **55**, 932.
310. Haensel, R., Baehr, P. and Elich, J., *Archives of Pharmaceuticals*, 1961, **294**, 739 (*Chemical Abstracts*, **56**, 11704).
311. Haensel, R., Ranft, G. and Baehr, P., *Zeitschrift für Naturforschung*, 1963, **18B**, 370 (*Chemical Abstracts*, **59**, 9017).
312. Dutta, C. P., Ray, L. P. K., Chatterjee, A. and Roy, D. N., *Indian Journal of Chemistry*, 1973, **11**, 509.
313. Dutta, C. P., Roy, L. P. K., Chatterjee, A. and Roy, D. N., *Journal of the Indian Chemical Society*, 1976, **53**, 1194.
314. Tillequin, F., Paris, M., Jacquemin, H. and Paris, R. R., *Planta Medica*, 1978, **33**, 46.
315. Jain, S. C., Handa, S., Singh, A., Kumar, R., Sharma, S. K., Babu, B. R., Parmar, V. S., Olsen, C. E. and Wengel, J., *Phytochemistry* (under publication).
316. Dhar, K. L., Atal, C. K. and Pelter, A., *Planta Medica*, 1970, **18**, 332.
317. Voesgen, B. and Herrmann, K., *Zeitschrift Lebensmen Untersuchung Forschung*, 1980, **170**, 204 (*Chemical Abstracts*, **93**, 6293).
318. Satyavati, G. V., in *Medicinal Plants of India*, Vol. 1. ICMR, New Delhi, 1976, p. 242.
319. Atal, C. K., Singh, J. and Dhar, K. L., *Tetrahedron*, 1970, **26**, 4403.
320. Singh, J., Dhar, K. L. and Atal, C. K., *Current Science*, 1969, **38**, 471.
321. Taneja, S. C., Koul, S. K., Pushpangadan, P., Dhar, K. L., Daniewski, W. M. and Schilf, W., *Phytochemistry*, 1991, **30**, 871.
322. Haranath, P. S. R. K., Akther, M. H. and Sharif, S. I., *Phytotherapy Research*, 1987, **1**, 91 (*Chemical Abstracts*, **109**, 5439).
323. Durand, E., Ellington, E. V., Feng, P. C., Haynes, L. J., Magnus, K. E. and Philip, N., *Journal of Pharmaceuticals and Pharmacology*, 1962, **14**, 562.
324. Sharma, R. K., Rathore, V. K. S. and Kumar, S., *Journal of Scientific Research in Plants and Medicines*, 1983, **44**, 63.
325. Schulz, J. M. and Herrmann, K., *Zeitschrift Lebensmen Untersuchung Forschung*, 1980, **171**, 193 (*Chemical Abstracts*, **95**, 78676).
326. Daulatabad, C. D., Mulla, G. M. and Mirajkar, A. M., *Fett.-Wissenschaft Technologie*, 1995, **97**, 453 (*Chemical Abstracts*, **124**, 174024).
327. Jossang, P. and Molho, D., *Journal of Chromatography*, 1967, **31**, 375.
328. Desai, H. K., Gawad, D. H., Govindachari, T. R., Joshi, B. S., Kamat, V. N., Parthasarathy, P. C., Ramachandran, K. S., Shanbhag, M. N., Sidhaye, A. R. and Viswanathan, N., *Indian Journal of Chemistry*, 1975, **13**, 97.
329. Takahashi, S., *Chemical and Pharmaceutical Bulletin*, 1970, **18**, 199.
330. Ma, Y. and Han, G., *Journal of Chinese Pharmaceutical Science*, 1993, **2**, 97 (*Chemical Abstracts*, **120**, 319345).
331. Ho, C. F., Lu, Y. C., Tsai, T. K., Chiu, Y. C., Lai, C. and Wang, H. S., *Yao Hsueh T'ung Pao*, 1981, **16**, 63 (*Chemical Abstracts*, **95**, 138470).
332. Pelter, A., Al-Bayati, R., Haensel, R., Dinter, H. and Burke, B., *Tetrahedron Letters*, 1981, **22**, 1545.
333. Maxwell, A. and Rampersad, D., *Journal of Natural Products*, 1988, **51**, 370.

334. De Nunez, E. H. and Johnson, C. H., *Journal of the American Pharmaceutical Association*, 1943, **32**, 234 (*Chemical Abstracts*, **37**, 6090).
335. Diaz, P. P., Ramos, B. C. and Matta, G. E., *Journal of Natural Products*, 1986, **49**, 690.
336. Gupta, O. P., Atal, C. K. and Gaind, K. N., *Indian Journal of Chemistry*, 1972, **10**, 874.
337. Maxwell, A. and Rampersad, D., *Journal of Natural Products*, 1989, **52**, 614.
338. Simmonds, N. W. and Stevens, R., *Nature*, 1956, **178**, 752.
339. Valyasevi, A. and Dhanamitta, S., *American Journal of Clinical Nutrition*, 1974, **27**, 877 (*Chemical Abstracts*, **82**, 81472).
340. Singh, J., Dhar, K. L. and Atal, C. K., *Indian Journal of Pharmaceuticals*, 1971, **33**, 50 (*Chemical Abstracts*, **76**, 11988).
341. Galinis, D. L. and Wiemer, D. F., *Journal of Organic Chemistry*, 1993, **58**, 7804.