Phytopharmacology

Ethnomedicinal, phytochemical, and pharmacological profile of the genus *Dalbergia* L. (Fabaceae)

Sanjib Saha[1*], Jamil A. Shilpi[1], Himangsu Mondal[1], Faroque Hossain[1], Md. Anisuzzman[1], Md. Mahadhi Hasan[1], Geoffrey A. Cordell[2]

[1]Pharmacy Discipline, Life Science School, Khulna University, Khulna 9208, Bangladesh.
[2]Natural Products Inc., Evanston, IL 60203, USA.

[*]Corresponding author: sanjibsaha1991@yahoo.com; Tel: +880-1717-986703

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Abstract

Dalbergia is a large genus of trees, shrubs, lianas, and woody climbers in the pea family, the Fabaceae, consisting of approximately 274 accepted species widely distributed in the tropical and subtropical regions of the world. Members of the genus enjoy a number of traditional uses all over the world. Various species are widely used in the treatment of different ailments like aphthae, bleeding piles, cough, diarrhea, dysentery, dyspepsia, epigastria, epistaxis, gonorrhea, haemorrhages, leprosy, malaria, rheumatism, scabies, scalding urine, stomach ache, syphilis, traumatic injuries, and ulcers, etc. Species are also used for their analgesic, anthelmintic, anti-inflammatory, antimicrobial, antipyretic, anti-spermicidal, anti-ulcerogenic, aphrodisiac, astringent, expectorant, and larvicidal activities in traditional medicine. Some species are already validated through different pharmacological investigations, and others require scientific investigations to rationalize their traditional uses. Phytochemical investigations of this genus have isolated different groups of compounds including isoflavonoids, neoflavonoids, glycosides, cinnamylphenols, quinones, furans, and other miscellaneous compounds. This comprehensive review is a compilation of information regarding the ethnomedicinal, phytochemical, and pharmacological data of the genus *Dalbergia*.

Keywords: *Dalbergia*; ethnomedicinal; phytochemical; pharmacological

Introduction

The family Fabaceae (alternatively known as the Leguminosae) is one of the largest families of flowering plants, consisting of 730 genera and over 19,400 species (Stevens, 2008). The genus *Dalbergia* is placed under the subfamily Faboideae containing 274 International Legume Database & Information Service (ILDIS) accepted species distributed all over the world, especially in the tropical and subtropical regions. Most *Dalbergia* species are widely used timber trees, and are valuable because of their decorative and fragrant wood (Chopra *et al.*, 1980). Many species are used in traditional system of medicines all over the world in the treatment of various ailments like diarrhea, leucoderma, dyspepsia, dysentery, syphilis, gonorrhea, stomach ache, leprosy, eye diseases, scabies, pain, and ringworm (Pooley et al., 1993; Ghani, 1999; Khare, 2007; Kazembe et al., 2012). Traditionally, they are also used for their analgesic, antimicrobial, aphrodisiac, anthelmintic, antipyretic, anti-inflammatory, and larvicidal activities (Nadkarni 1954; Kirtikar et al., 1991). Only a few species have been subjected to pharmacological investigations in order to rationalize their traditional uses. Several phytoconstituents like isoflavonoids, neoflavonoids, glycosides, cinnamylphenols, quinones, and furans have been isolated from different species. The present comprehensive review is a compilation of geographical distribution, ethnomedicinal uses, isolated phytoconstituents, and pharmacological activities of the genus *Dalbergia*.

The genus *Dalbergia*

The plants of the genus *Dalbergia* L. are small- to medium-sized trees, shrubs, climbers, and lianas with leathery, alternate, imparipinnate, and compound leaves. Leaflets are alternate, rarely, some subopposite and glabrous. Corolla small, rarely fragrant, white to cream, sometimes flushed purplish. Fruits are oblong-lanceolate, indehiscent, usually flattened, and seeded (Chopra et al., 1980). Seeds are kidney shaped, thin and flat, light brown in color. Root nodulation is very common. Several species are cultivated commercially for their colored timber used in the furniture industries. In Bangladesh, *Dalbergia lanceolaria* L.f., *Dalbergia latifolia* Roxb., *Dalbergia sissoo* Roxb., *Dalbergia spinosa* Roxb., *Dalbergia stipulacea* Roxb., and *Dalbergia volubilis* Roxb. are commonly available and widely used in traditional medicines (Ghani, 1999). A list of some important *Dalbergia* species, along with their geographical distribution, is indicated in Table 1. Both indigenous and introduced countries are mentioned for each species. Among 274 species most common species are included in this table to express geographical distribution. *Index Kewensis* (IK) assaingments for each species from IPNI website are mentioned in the table.

Table 1. Selected *Dalbergia* species and their worldwide distribution.

Botanical Name	*Index Kewensis* (IK)	Geographical Distribution
Dalbergia albertisii Prain	J. Asiat. Soc. Bengal, Pt. 2, Nat. Hist. 70: 62. 1901 [14 Aug 1901]	Indonesia, Irian Jaya, Papua New Guinea and Solomon Is
Dalbergia amazonica (Radlk.) Ducke	–	Brazil, Guyana and Venezuela
Dalbergia arbutifolia Baker	Fl. Trop. Afr. [Oliver et al.] 2: 232. 1871	Malawi, Mozambique, Tanzania, Zaire, Zambia and Zimbabwe
Dalbergia assamica Benth.	Pl. Jungh. [Miquel] 256, in adnot.	China, India, Kenya and Myanmar
Dalbergia balansae Prain	J. Asiat. Soc. Bengal, Pt. 2, Nat. Hist. 70: 54. 1901 [14 Aug 1901]	China, Hainan and Vietnam
Dalbergia baronii Baker	J. Linn. Soc., Bot. 21: 337. 1884 [1886 publ. 1884]	Madagascar
Dalbergia beccarii Prain	J. Asiat. Soc. Bengal, Pt. 2, Nat. Hist. 70: 64. 1901 [14 Aug 1901]	Brunei, Indonesia, Malaysia, Papua New Guinea, Peninsular Malaysia, Sarawak and Solomon Is
Dalbergia benthamii Prain	J. Asiat. Soc. Bengal, Pt. 2, Nat. Hist. 67(2): 289, as 'benthami'. 1898	China and Hainan

Dalbergia boehmii Taub.	Pflanzenw. Ost-Afrikas C (1895) 218.	Angola, Cameroon, Central African Rep., Guinea Bissau, Kenya, Malawi, Mozambique, Senegal, Sudan, Tanzania, Zaire, Zambia and Zimbabwe
Dalbergia bracteolate Baker	Fl. Trop. Afr. [Oliver et al.] 2: 234. 1871	Kenya, Madagascar, Mozambique, and Tanzania
Dalbergia brownie	–	Belize, Colombia, Costa Rica, Guatemala, Mexico, Panama, United States and Venezuela.
Dalbergia candenatensis Prain	J. Asiat. Soc. Bengal, Pt. 2, Nat. Hist. 70: 49. 1901 [14 Aug 1901]	Andaman Is, Australia, Bangladesh, Bismarck Archipelago, Brunei, Burma, China, Fiji, India, Indonesia, Malaysia, Micronesia Federated States, Moluccas, Myanmar, Nicobar Is, Northern Marianas, Papua New Guinea, Peninsular Malaysia, Philippines, Ryukyu Is, Sabah, Sarawak, Singapore, Solomon Is, Sri Lanka, Sulawesi, Sumatera, Thailand and Vietnam
Dalbergia cearensis Ducke	Arch. Jard. Bot. Rio de Janeiro iv. 73 (1925).	Brazil, Mexico
Dalbergia chapelieri Baill.	Bull. Mens. Soc. Linn. Paris i. (1884) 436.	Madagascar
Dalbergia chontalensis Standl. & L.O.Williams	Ceiba i. 81 (1950).	Nicaragua
Dalbergia congestiflora Pittier	J. Wash. Acad. Sci. 1922, xii. 57.	Mexico
Dalbergia coromandeliana Prain	J. Asiat. Soc. Bengal, Pt. 2, Nat. Hist. 70: 60. 1901 [14 Aug 1901]	India
Dalbergia cuiabensis	–	Bolivia and Brazil
Dalbergia cultrate Graham	Numer. List [Wallich] n. 5861. [1831-32]	India, Laos, Myanmar, Thailand and Vietnam
Dalbergia cuscatlanica (Standl.) Standl.	Publ. Field Mus. Nat. Hist., Bot. Ser. 4: 215. 1929	Costa Rica, Guatemala, Mexico and Panama.
Dalbergia ecastaphyllum Taub.	–	Angola, Antigua-Barbuda, Bahamas, Barbados, Belize, Brazil, Cameroon, Cayman Is, Colombia, Costa Rica, Cuba, Dominica, Dominican Republic, French Guiana, Ghana, Grenada, Guadeloupe, Guatemala, Guyana, Haiti, India, Ivory Coast, Liberia, Martinique, Mauritius, Mexico, Montserrat, Nigeria, Panama, Peru, Puerto Rico, Reunion, Senegal, Sierra Leone, St Vincent, Surinam, Togo, Trinidad & Tobago, United States and Venezuela
Dalbergia eremicola Polhill	Kew Bull. xxiii. 483 (1969).	Kenya and Somalia
Dalbergia fischeri Taub.	Pflanzenw. Ost-Afrikas C (1895) 218.	Malawi, Mozambique, Tanzania, Zambia and Zimbabwe
Dalbergia foliosa T.S.Ralph	Icon. Carpolog. 22. 1849 [Apr-May 1849]	Brazil, Colombia, French Guiana, Surinam and Venezuela
Dalbergia frutescens Britton	Bull. Torrey Bot. Club xvi. (1889) 324.	Argentina, Brazil, Guyana, Paraguay and Venezuela
Dalbergia fusca Pierre	Fl. Forest. Cochinch. t. 381 A.	China
Dalbergia gardneriana Benth.	J. Proc. Linn. Soc., Bot. 4(Suppl.): 42. 1860	India
Dalbergia glabra Standl.	Publ. Field Mus. Nat. Hist., Bot. Ser. 8: 15. 1930	Belize, Costa Rica, Guatemala, Honduras and Mexico
Dalbergia glaziovii Harms	Repert. Spec. Nov. Regni Veg. 24: 212. 1928	Brazil
Dalbergia greveana Baill.	Bull. Mens. Soc. Linn. Paris i. (1884) 436.	Madagascar
Dalbergia havilandii Prain	J. Asiat. Soc. Bengal, Pt. 2, Nat. Hist. 70: 45. 1901 [14 Aug 1901]	Brunei, Malaysia and Sarawak
Dalbergia inundata	J. Asiat. Soc. Bengal, Pt. 2, Nat. Hist. 70: 45. 1901 [14 Aug 1901]	Brazil, Colombia, Guyana, Peru and Venezuela
Dalbergia junghuhnii Benth.	Pl. Jungh. [Miquel] 254.	Indonesia, Malaysia and Singapore

Dalbergia kurzii Prain	J. Asiat. Soc. Bengal, Pt. 2, Nat. Hist. 66: 450. 1897 [1898 publ. 1897]	Laos and Myanmar
Dalbergia lanceolaria L.f.	Suppl. Pl. 316. 1782 [1781 publ. Apr 1782]	Bangladesh and Pakistan
Dalbergia latifolia Roxb.	Pl. Coromandel ii. 7. t. 113.	Bangladesh and Pakistan
Dalbergia louvelii		Madagascar
Dalbergia malabarica Prain	J. Asiat. Soc. Bengal, Pt. 2, Nat. Hist. 70: 48. 1901 [14 Aug 1901]	India
Dalbergia melanoxylon Guill. & Perr.	Fl. Seneg. Tent. i. 227. t. 53.	Angola, Botswana, Burkina Faso, Chad, Ethiopia, India, Ivory Coast, Kenya, Malawi, Mali, Mozambique, Nigeria, Senegal, South Africa, Sri Lanka, Sudan, Tanzania, Uganda, Zaire, Zambia and Zimbabwe
Dalbergia microphylla Chiov.	Ann. Bot. (Rome) 13: 385. 1915	Ethiopia, Kenya, Somalia and Tanzania
Dalbergia mimosella Prain	Ann. Roy. Bot. Gard. (Calcutta) x. 42.	Indonesia, Malaysia and Philippine
Dalbergia miscolobium Benth.	J. Proc. Linn. Soc., Bot. 4(Suppl.): 35. 1860; et in Fl. Bras. (Martius) 15(1): 222 (1862)	Brazil
Dalbergia mollis Bosser & R.Rabev.	Bull. Mus. Natl. Hist. Nat., B, Adansonia Sér. 4, 18(3-4): 211, nom. nov. 1996	Madagascar
Dalbergia monetaria L.f.	Suppl. Pl. 317. 1782 [1781 publ. Apr 1782]	Belize, Brazil, Colombia, Costa Rica, Cuba, Dominican Republic, French Guiana, Guadeloupe, Guatemala, Guyana, Haiti, Honduras, Jamaica, Martinique, Mexico, Panama, Peru, Puerto Rico, St Vincent, Surinam and Venezuela
Dalbergia nigra Allem. ex Benth.	J. Proc. Linn. Soc., Bot. 4(Suppl.): 36. 1860; et in Fl. Bras. (Martius) 15(1): 224 (1862)	Brazil
Dalbergia nitidula Welw. ex Baker	Fl. Trop. Afr. [Oliver et al.] 2: 235. 1871	Tropical Africa
Dalbergia obovata E.Mey.	Comm. Pl. Afr. Austr. (Meyer) 152.	Mozambique, South Africa and Tanzania
Dalbergia obtusifolia Prain	J. Asiat. Soc. Bengal, Pt. 2, Nat. Hist. 70: 42. 1901 [14 Aug 1901]	China, Myanmar and Thailand
Dalbergia odorifera T.C.Chen	Acta Phytotax. Sin. viii. 351 (1963).	China
Dalbergia oliveri Gamble ex Prain	J. Asiat. Soc. Bengal, Pt. 2, Nat. Hist. 66: 451. 1897 [1898 publ. 1897]	East Indies
Dalbergia parviflora Roxb.	Hort. Bengal. 98; Fl. Ind. iii. 225.	Borneo, Brunei, Burma, Indonesia, Laos, Malaysia, Moluccas, Myanmar, Malaysia, Singapore and Thailand
Dalbergia pervillei Vatke	Linnaea 43: 106. 1881	Madagascar
Dalbergia retusa Hemsl.	Diagn. Pl. Nov. Mexic. 1: 8. 1878 [Jul 1878]	Costa Rica, El Salvador, Mexico, Nicaragua and Panama
Dalbergia rubiginosa Roxb.	Pl. Coromandel ii. 9. t. 115.	China and India
Dalbergia saxatilis Hook.f.	Niger Fl. [W. J. Hooker]. 314. 1849 [Nov-Dec 1849]	Angola, Cameroon, Gabon, Ghana, Guinea, Guinea Bissau, Ivory Coast, Liberia, Nigeria, Senegal, Sierra Leone, Togo and Zaire
Dalbergia sissoides Graham	Numer. List [Wallich] n. 5876. [1831-32]	India and Indonesia
Dalbergia sissoo Roxb.	Hort. Bengal. 53; Fl. Ind. iii. 223.	Bangladesh and Pakistan
Dalbergia spinosa Roxb.	Hort. Bengal. [98]; Fl. Ind. iii. 233.	Bangladesh, Burma, India, Malaysia, and Myanmar
Dalbergia stevensonii Standl.	Trop. Woods No. 12, 4 (1927).	Belize

Dalbergia stipulacea Roxb.	Hort. Bengal. 53; Fl. Ind. iii. 233.	Bangladesh, Bhutan, China, India, Indonesia, Laos, Malaysia, Moluccas, Myanmar, Nepal, Papua New Guinea, Philippines, Solomon Is, Thailand and Vietnam
Dalbergia subcymosa Ducke	Arch. Jard. Bot. Rio de Janeiro iii. 144 (1922).	Brazil, French Guiana, Guyana, Peru, Surinam and Venezuela
Dalbergia sympathetica Nimmo	in J. Grah. Cat. Pl. Bomb. 55.	India
Dalbergia trichocarpa Baker	J. Linn. Soc., Bot. 25: 311. 1890 [28 Jan 1890]	Madagascar
Dalbergia tucurensis Donn.Sm.	Bot. Gaz. 46: 111. 1908	Belize, Costa Rica, Guatemala, Honduras and Mexico
Dalbergia vacciniifolia Vatke	Oesterr. Bot. Z. 28: 263. 1878	Kenya and Tanzania
Dalbergia volubilis Roxb.	Pl. Coromandel ii. 48. t. 191.	Bangladesh, China, India, Laos, Myanmar, Nepal, Sri Lanka, Thailand and Vietnam.

Ethnomedicinal uses

A number of ethnomedicinal uses of different species of the *Dalbegia* genus have been documented and published. Many species are widely used in the treatment of various ailments in different communities all over the world. After conducting a literature survey, a comprehensive list of the different species used, along with their routes of administration and traditional uses, is presented in Table 2.

Table 2. Ethnomedicinal uses of various species of genus *Dalbergia*.

Botanical Name	Part Used (Route of Administration)	Traditional Medicinal Uses (References)
Dalbergia lanceolaria L.f.	Leaves, bark and seeds (oral)	A decoction of the bark is used in dyspepsia, leaves are used in leprosy and allied obstinate skin diseases. Seed oil is used in rheumatism and cutaneous diseases (Khare, 2007).
Dalbergia latifolia Roxb.	Bark and whole plant (oral)	Bark is used in body pain, and whole plant is used in diarrhea, dyspepsia, leprosy and obesity. Whole plant is also used as stomachic, anthelmintic and bitter tonic (Ghani, 1999; Khare, 2007).
Dalbergia melanoxylon Guill. & Perr.	Leaves, stem and root bark (oral, topical)	In Senegal, stem and root bark are used in the treatment of diarrhea with baobab or tamarind fruits. Smoke of burnt roots is inhaled in colds, bronchitis and headache. Smoke of burnt stems is inhaled to treat rheumatism in Sudan. A decoction of roots is used as anthelmintic and aphrodisiac, and applied in the treatment of gonorrhoea, stomach-ache and abdominal pain. A decoction of bark is used in healing wounds. Leaf decoction is used in relief of joint pain, and leaf sap is taken to treat inflammation in mouth and throat (Bolza et al., 1972; Neuwinger et al., 2000).
Dalbergia nitidula Welw. ex Baker	Leaves (topical), roots (oral, topical) and bark (oral)	Chewed leaves are applied to treat snakebites and leaves are rubbed on abscesses. Powdered root soaked in warm water is gargled to treat toothache and root decoction and infusion is used in the treatment of malaria and cough. In Zimbabwe, bark is used to treat wounds and ulcers (Kazembe et al., 2012).
Dalbergia obovata E.Mey.	Roots (infusion) and bark (topical)	A root infusion is used in the treatment of stomach-ache and toothache (Louppe et al., 2008). Bark is applied to treat sore mouths in babies (Pooley et al., 1993).
Dalbergia odorifera T.C.Chen	Heartwood (oral)	Heartwood is used in Chinese traditional medicine in the treatment of ischemia, blood stagnation syndrome swelling, rheumatic pain, epigastria, traumatic injuries and necrosis (Kang et al., 2005; Hou et al., 2011)
Dalbergia sissoides Graham	Roots (oral)	Anti-inflammatory (Khare, 2007).

Dalbergia sissoo Roxb.	Leaves, Bark, wood, roots and whole plant (oral)	Leaf juice is used for eye ailments, and wood is used in the treatment of blood disorders, burning sensations, scabies, stomach problems, scalding urine, epistaxis, hemorrhage, eye and nose disorders, syphilis and bleeding piles (Kirtikar et al., 1993). Bark and wood are applied as expectorant, astringent, anthelmintic, aphrodisiac, antipyretic and used in diseases of the blood, dyspepsia and dysentery (Kirtikar et al., 1975). Extract of wood rasping is very useful in leprosy, and roots are used as astringent (Ghani, 1998). Decoction of leaves is also prescribed in acute gonorrhea, and whole plant is used in ancient Yunani preparations and in the treatment of skin diseases and gonorrhea (Kirtikar et al., 1975; Nadkarni, 1954).
Dalbergia spinosa Roxb.	Fruits, leaves and stem barks (oral)	Fruits are used as tonic and antipyretic. Leaves and stem bark are applied as febrifuge and anthelmintic (Naskar, 2004)
Dalbergia stipulacea Roxb.	Roots and leaves (oral)	Roots and leaves are used in the treatment of gonorrhoea and aphthae (Yusuf et al., 1994)
Dalbergia sympathetica Nimmo	Bark (topical), leaves and aerial parts (oral)	Paste of bark is used in the treatment of pimples. Leaves are used as alterative, and aerial parts as spasmolytic, CNS active and hypothermic (Khare, 2007).
Dalbergia volubilis Roxb.	Leaves, roots and aerial parts (oral)	Decoction of leaves is used as anti-inflammatory and antiarthritic, applied in aphthae, and also used in sore-throat as gargle. Juice of roots is used in gonorrhea. Aerial parts are applied as diuretics (Ghani, 1998, Khare, 2007).

Phytochemical studies

A number of phytochemical types, including isoflavonoids, neoflavonoids, glycosides, cinnamylphenols, quinones, furans, steroids, and other miscellaneous compounds have been isolated from various species of the *Dalbergia* genus. Following a literature survey, the isolated and characterized compounds are tabulated in Table 3, and bioactive compounds along with their activity are tabulated in Table 4. Structures of all the mentioned compounds are presented in Table 5.

The highest investigated plant part is the heartwood while most of the reported compounds are phenolic compounds. A wide range of flavanoids namely, flavones, isoflavones, neoflavones and chalcones have been isolated either in their aglycone form or as glycosides. Glucose is the most common sugar of the glycosides while some glycosides also contain rhamnose and galactose. So far various species of the genus *Dalbergia* including *D. volubilis*, *D. sissoides*, *D. sissoo*, *D. parviflora*, *D. coromandeliana*, *D. lanceolaria* yielded apioglucosides which is rare in nature (Malhotra et al., 1967; Ramesh et al., 1995; Farag et al., 2001; Umehara et al., 2009; Dixit et al., 2012). Therefore, isoflavone apioglucoside can be considered as a chemotaxonomic marker of *Dalbergia* (Innocent, 2012). Only *D. nitidula* and *D. monetaria* has yielded diflavonoids so far (Bezuidenhoudt et al., 1984; Bezuidenhoudt et al., 1988; Nunes et al., 1989). Some of the flavonoids isolated from *D. nitidula*, *D. stipulacea*, *D. oliveri*, *D. candenatensis* have isoprene unit attached to the ring (Van Heerden et al., 1978; Ito et al., 2003b; Bhatt et al., 1992; Cheenpracha et al., 2012). Flavonoids act as chemoattractant for the formation of root nodule in Leguminosae family and this might be reason for abundant presence of flavonoids in *Dalbergia* (Zuanazzi et al, 1998).

Plants of the legume family are well known for the production of nitrogen containing compounds due to the presence of nitrogen fixing bacterial in root nodules. Among the

Table 3. Phytochemicals isolated from various species of genus *Dalbergia*.

Compound (Structure Number)	Plant Name (Part)	Reference
Alpinetin (**1**)	*D. parviflora* (heartwood)	Umehara et al., 2008
Biochanin A (**2**)	*D. volubilis* (flowers), *D. sissoides* (flowers), *D. sissoo* (leaves), *D. parviflora* (heartwood)	Chawla et al., 1974; Kavimani et al., 1997; Dixit et al., 2012; Umehara et al., 2009
Biochanin A 7-*O*-[β-D-apiofuranosyl-(1→5)-β-D-apiofuranosyl-(1→6)-β-D-glucopyranoside] (**3**)	*D. sissoo* (leaves)	Farag et al., 2001
Biochanin A 7-*O*-apiosyl-(1→6)-glucoside (**4**)	*D. sissoo* (leaves)	Farag et al., 2001
Biochanin A 7-*O*-glucoside (**5**)	*D. sissoo* (leaves)	Dixit et al., 2012
Biochanin A 7-*O*-rutinoside (**6**)	*D. paniculata* (bark)	Parthasarathy et al., 1976
Bowdichione (**7**)	*D. parviflora* (heartwood), *D. odorifera* (heartwood)	Umehara et al., 2009; Chan et al., 1998
Butein (**8**)	*D. odorifera* (heartwood)	Liu et al., 2005; Chan et al., 1998; Cheng et al., 1998
Butin (**9**)	*D. odorifera* (heartwood)	Liu et al., 2005
Cajanin (**10**)	*D. parviflora* (heartwood)	Umehara et al., 2008
(3*R*)-Calussequinone (**11**)	*D. odorifera* (heartwood)	Choi et al., 2009
Calycosin (**12**)	*D. parviflora* (heartwood), *D. cochinchinensis* (heartwood)	Umehara et al., 2009; Kuroyanagi et al., 1996
Campesterol (**13**)	*D. monetaria*	Khan et al., 1997
Candenatenin A (**14**)	*D. candenatensis* (heartwood)	Cheenpracha et al., 2009
Candenatenin B (**15**)	*D. candenatensis* (heartwood)	Cheenpracha et al., 2009
Candenatenin C (**16**)	*D. candenatensis* (heartwood)	Cheenpracha et al., 2009
Candenatenin D (**17**)	*D. candenatensis* (heartwood)	Cheenpracha et al., 2009
Candenatenin E (**18**)	*D. candenatensis* (heartwood)	Cheenpracha et al., 2009
Candenatenin F (**19**)	*D. candenatensis* (heartwood)	Cheenpracha et al., 2009
Candenatenin G (**20**)	*D. candenatensis* (heartwood)	Cheenpracha et al., 2012
Candenatenin H (**21**)	*D. candenatensis* (heartwood)	Cheenpracha et al., 2012
Candenatenin I(**22**)	*D. candenatensis* (heartwood)	Cheenpracha et al., 2012
Candenatenin J (**23**)	*D. candenatensis* (heartwood)	Cheenpracha et al., 2012
Candenatenin K (**24**)	*D. candenatensis* (heartwood)	Cheenpracha et al., 2012
Candenatone (**25**)	*D. candenatensis* (heartwood)	Hamburger et al., 1988
Carthamidin (**26**)	*D. odorifera* (heartwood)	Zhao et al., 2011
Cavunin (**27**)	*D. paniculata* (seeds, leaves)	Radhakrishniah, 1973; Rao et al., 1992
Caviunin 7-*O*-[*β*-D-apiofuranosyl-(1→6)-*β*-D-glucopyranoside] (**28**)	*D. sissoo* (leaves)	Dixit et al., 2012
Caviunin 7-*O*-glucoside (**29**)	*D. sissoo* (pods)	Sharma et al., 1980
Caviunin 7-O-rhamnoglucoside (**30**)	*D. paniculata* (root)	Rajulu et al., 1980
Cearoin (**31**)	*D. odorifera* (heartwood)	Chan et al., 1998
Coromandelin (**32**)	*D. coromandeliana* (leaves)	Ramesh et al., 1995
Daidzein (**33**)	*D. ecastaphyllum* (wood)	Matos et al., 1975
Dalberatins A (**34**)	*D. cultrata* and *D. nigrescens* (stem-bark)	Ito et al., 2003a
Dalberatins B (**35**)	*D. cultrata* and *D. nigrescens* (stem-bark)	Ito et al., 2003a
Dalberatins C (**36**)	*D. cultrata* and *D. nigrescens* (stem-bark)	Ito et al., 2003a
Dalberatins D (**37**)	*D. cultrata* and *D. nigrescens* (stem-bark)	Ito et al., 2003a
Dalberatins E (**38**)	*D. cultrata* and *D. nigrescens* (stem-bark)	Ito et al., 2003a
R(+)-Dalbergiphenol (**39**)	*D. odorifera* (heartwood)	An et al., 2008
Dalbergichromene (**40**)	*D. sissoo* (stem bark, heartwood)	Mukerjee et al., 1971
Dalbergin (**41**)	*D. cultrata* (heartwood)	Donnelly et al., 1972
Dalbinol (**42**)	*D. latifolia* (seeds)	Chibber et al., 1978
Dalbinol *O*-glucoside (**43**)	*D. monetaria* (seeds)	Abe et al., 1985
Daljanelin A (**44**)	*D. nitidula* (heartwood)	Ferreira et al., 1995
Daljanelin B (**45**)	*D. nitidula* (heartwood)	Ferreira et al., 1995

Daljanelin C (**46**)	*D. nitidula* (heartwood)	Ferreira et al., 1995
Daljanelin D (**47**)	*D. nitidula* (heartwood)	Ferreira et al., 1995
Dalnigrin (**48**)	*D. nigra* (heartwood)	Kite et al., 2010
Dalpalatin (**49**)	*D. paniculata* (seeds)	Adinaraya et al., 1972
Dalpaniculin (**50**)	*D. paniculata* (seeds)	Rao et al., 1991
Dalpanin (**51**)	*D. paniculata* (seeds)	Adinarayana et al., 1972
Dalpanitin (**52**)	*D. paniculata* (seeds)	Adinarayana et al., 1972
Dalpanol (**53**)	*D. paniculata* (seeds)	Adinaraya et al., 1975
Dalparvin (**54**)	*D. parviflora* (heartwood)	Umehara et al., 2009
Dalparvin A (**55**)	*D. parviflora* (heartwood)	Umehara et al., 2008
Dalparvin B (**56**)	*D. parviflora* (heartwood)	Umehara et al., 2008
Dalparvin C (**57**)	*D. parviflora* (heartwood)	Umehara et al., 2008
Dalparvinene (**58**)	*D. parviflora* (stem)	Songsiang et al., 2009
Dalparvinol C (**59**)	*D. parviflora* (heartwood)	Umehara et al., 2008
Dalparvone (**60**)	*D. parviflora* (stem)	Songsiang et al., 2009
Dalpatein (**61**)	*D. paniculata* (seeds)	Adinaraya et al., 1972
Dalpatin (**62**)	*D. paniculata* (seeds)	Adinarayana et al., 1972
Dalspinin (**63**)	*D. spinosa* (root)	Gandhidasan et al., 1982
Dalspinosin (**64**)	*D. spinosa* (root)	Gandhidasan et al., 1982
Dalsympathetin (**65**)	*D. sympathetica*	Nagaranjan et al., 2006
Darbergiol (**66**)	*D. cochinchinensis* (heartwood)	Kuroyanagi et al., 1996
7-Demethylrobustigenin (**67**)	*D. parviflora* (heartwood)	Umehara et al., 2009
8-Demethylduartin (**68**)	*D. ecastaphyllum* (vine wood)	Donnelly et al., 1973a
Dehydrodalpanol *O*-glucoside (**69**)	*D. paniculata* (seeds)	Rao et al., 1991
12-Dihydrodalbinol (**70**)	*D. monetaria* (seeds)	Abe et al., 1985
12-Dihydrodalbinol *O*-glucoside (**71**)	*D. monetaria* (seeds)	Abe et al., 1985
Dihydrorotenone (**72**)	*D. monetaria* (seeds)	Abe et al., 1985
2,3-Dihydrobenzofuran (**73**)	*D. melanoxylon* (heartwood)	Donnelly et al., 1969
5,5′-Dihydroxy-2′,4′-dimethoxy-7-[(6-*O*-β-D-apiofuranosyl-β-D-glucopyranosyl)-oxy]-isoflavone (**74**)	*D. vacciniifolia* (root bark)	Innocent , 2012
7,3’-Dihydroxy-5,4’-dimethoxy-6-formyl-4-phenylcoumarin (**75**)	*D. volubilis*	Chawla et al., 1989
(3*R*)-7,2'-Dihydroxy-4',5'-dimethoxyisoflavanone (**76**)	*D. louvelii* (heartwood)	Beldjoudi et al., 2003
2,5-Dihydroxy-4-methoxybenzophenone (**77**)	*D. cochinchinensis* (heartwood)	Kuroyanagi et al., 1996
2,4-Dihydroxy-5-methoxybenzophenone (**78**)	*D. odorifera* (root)	Wang et al., 2000
(3*S*,4*S*)-3,4-*trans*-2',7-Dihydroxy-4'-methoxy-4-[(3*S*)-2',7-dihydroxy-4'-methoxyisoflavan-5'-yl]isoflavan (**79**)	*D. nitidula* (heartwood)	Bezuidenhoudt et al., 1984
7,4'-Dihydroxy-3'-methoxyisoflavone (**80**)	*D. louvelii* (heartwood)	Beldjoudi et al., 2003
(2*S*)-6,4′-Dihydroxy-7-methoxyflavan (**81**)	*D. odorifera* (heartwood)	An et al., 2008
6,4′-Dihydroxy-7-methoxyflavanone (**82**)	*D. odorifera* (heartwood)	An et al., 2008
3-(2,4-Dihydroxy-5-methoxy)phenyl-7-hydroxycoumarin (**83**)	*D. louvelii* (heartwood)	Beldjoudi et al., 2003
7,3’-Dihydroxy-4’-methoxy-4-phenylcoumarin (**84**)	*D. volubilis*	Chawla et al., 1989
6,2'-Dimethoxy-7,4'-dihydroxyisoflavone (**85**)	*D. vacciniifolia*	Innocent et al., 2010
Di-*O*-methyldaidzein (**86**)	*D. miscolobium* (heartwood)	Gregson et al., 1978b
Dinklagin A (**87**)	*D. candenatensis* (heartwood)	Cheenpracha et al., 2012
Elemicin (**88**)	*D. spruceana* (wood)	Cook et al., 1978
Epifisetinidol-(4β→8)-epicatechin (**89**)	*D. monetaria* (bark)	Nunes et al., 1989
Epiguibourtinidol-(4α→8)-epicatechin (**90**)	*D. monetaria* (bark)	Nunes et al., 1989
Eriodictoyl (**91**)	*D. odorifera* (heartwood)	Hou et al., 2011
Formononetin (**92**)	*D. odorifera* (root, heartwood)*, D. frutescans* (barks)	Yu et al., 2007; Choi et al., 2009; Khan et al., 2000
Formononetin 7-*O*-rutinoside (**93**)	*D. paniculata* (bark)	Parthasarathy et al., 1976
Friedelin (**94**)	*D. erruginea*	Donnelly et al. 1972
Genstein (**95**)	*D. sissoo* (leaves), *D. parviflora* (heartwood)	Dixit et al., 2012; Umehara et al., 2009
Genistein 8-*C*-glucoside (**96**)	*D. sissoo* (leaves)	Farag et al., 2001
8-*C*-glucosylprunetin (**97**)	*D. paniculata* (bark)	Parthasarathy et al., 1976
Hemileiocarpin (**98**)	*D. nitidula* (bark)	Van Heerden et al., 1978

Hesperetin (**99**)	*D. parviflora* (heartwood)	Umehara et al., 2008
Hexadecanoic acid, ethyl ester (**100**)	*D. odorifera* (root)	Wang et al., 2000
Hexanoic acid, 2-propenyl ester (**101**)	*D. odorifera* (root)	Wang et al., 2000
5-Hydroxybowdichione (**102**)	*D. candenatensis* (heartwood)	Hamburger et al., 1987
2-Hydroxy-3,4-dimethoxybenzaldehyde (**103**)	*D. odorifera* (heartwood)	Choi et al., 2009
9-Hydroxy-6,7-dimethoxydalbergiquinol (**104**)	*D. odorifera* (heartwood)	An et al., 2008
(*S*)-4′-Hydroxy-4-methoxydalbergione (**105**)	*D. nigra* (heartwood)	Kite et al., 2010
4-Hydroxymaackiain (**106**)	*D. spruceana* (wood)	Cook et al., 1978
3'-Hydroxymelanettin (**107**)	*D. odorifera* (heartwood)	Chan et al., 1997
Hydroxyobtustyrene (**108**)	*D. odorifera* (heartwood)	Choi et al., 2009
1-(3-Hydroxyphenyl)-3-(4-hydroxy-2,5-dimethoxyphenyl)propane (**109**)	*D. louvelii* (heartwood)	Beldjoudi et al., 2003
4-Hydroxypterocarpin (**110**)	*D. spruceana* (wood)	Cook et al., 1978
3'-Hydroxy-2,4,5-trimethoxydalbergiquinol (**111**)	*D. odorifera* (heartwood)	Chan et al., 1997
7-Hydroxy-2',4',5'-trimethoxyisoflavone (**112**)	*D. monetaria* (seeds)	Abe et al., 1985
7-Hydroxy-2',4',5'-trimethoxyisoflavone 7-*O*-glucoside (**113**)	*D. monetaria* (seeds)	Abe et al., 1985
Isocavuinin-7-*O*-glucoside (**114**)	*D. paniculata* (bark))	Parthasarathy et al., 1980
Isodalbergin (**115**)	*D. sissoo* (stem bark, heartwood)	Mukerjee et al., 1971
Isoliquiritigenin (**116**)	*D. louvelii* (heartwood), *D. odorifera* (heartwood), *D. cochinchinensis* (heartwood)	Beldjoudi et al., 2003; Zhao et al., 2011; Kuroyanagi et al., 1996
Isoparvifuran (**117**)	*D. parviflora* (heartwood), *D. odorifera* (heartwood)	Muangnoicharoen et al., 1981; An et al., 2008
Isoviolastyrene (**118**)	*D. miscolobium* (heartwood)	Gregson et al., 1978b
Isovolubilin (**119**)	*D. volubilis* (flowers)	Chawla et al., 1974
Kenusanone G (**120**)	*D. parviflora* (heartwood)	Umehara et al., 2008
6-Keto-dehydroamorphigenin (**121**)	*D. sissoides* (stem-bark)	Sripathi et al., 1994
Khrinone A (**122**)	*D. parviflora* (heartwood)	Umehara et al., 2009
Khrinone B (**123**)	*D. parviflora* (heartwood)	Umehara et al., 2009
Khrinone C (**124**)	*D. parviflora* (heartwood)	Umehara et al., 2009
Khrinone D (**125**)	*D. parviflora* (heartwood)	Umehara et al., 2009
Khrinone E (**126**)	*D. parviflora* (heartwood)	Umehara et al., 2009
Koparin (**127**)	*D. odorifera* (heartwood)	Chan et al., 1998
Lanceolarin (**128**)	*D. lanceolaria* (root-bark)	Malhotra et al., 1967
Latifolin (**129**)	*D. parviflora* (heartwood), *D. odorifera* (heartwood), *D. cochinchinensis* (heartwood)	Muangnoicharoen et al., 1982; An et al., 2008; Kuroyanagi et al., 1996
Latinone (**130**)	*D. latifolia* (heartwood)	Criodain et al., 1981
Leiocarpin (**131**)	*D. nitidula* (bark)	Van Heerden et al., 1978
Leiocin (**132**)	*D. nitidula* (bark)	Van Heerden et al., 1978
Leiocinol (**133**)	*D. nitidula* (bark)	Van Heerden et al., 1978
Liquiritigenin (**134**)	*D. odorifera* (heartwood), *D. cochinchinensis* (heartwood)	Liu et al., 2005; Zhao et al., 2011; Choi et al., 2009; Kuroyanagi et al., 1996
Luteolin (**135**)	*D. stipulacea* (leaves)	Borai et al., 1993
Luteolin 4'-rutinoside (**136**)	*D. spruceana* (leaves)	Borai et al., 1993
(–)-Medicarpin (**137**)	*D. stevensonii* (heartwood), *D. odorifera* (root, heartwood)	Donnelly et al., 1973b; Wang et al., 2000; Choi et al., 2009
(+)-(6a*S*,11a*S*)-Medicarpin (1**38**)	*D. volubilis* (flowers), *D. congestiflora* (heartwood)	Chawla et al., 1976; ; Martínez-Sotres et al., 2012
Melanettin (**139**)	*D. odorifera* (heartwood)	Liu et al., 2005
Melannein (**140**)	*D. baronii* (heartwood)	Donnelly et al., 1968
Melanoxin (**141**)	*D. melanoxylon* (heartwood)	Donnelly et al., 1969
Melilotocarpan A (**142**)	*D. candenatensis* (heartwood)	Cheenpracha et al., 2012
2'-Methoxybiochanin A (**143**)	*D. parviflora* (heartwood)	Umehara et al., 2009
3′-Methoxydaidzein (**144**)	*D. odorifera* (root)	Wang et al., 2000
R(+)-4-Methoxydalbergione (**145**)	*D. odorifera* (heartwood), *D. louvelli* (heartwood), *D. candenatensis* (heartwood), *D. cochinchinensis* (heartwood)	An et al., 2008; Beldjoudi et al., 2003; Cheenpracha et al., 2012; Kuroyanagi et al., 1996

(*S*)-4-Methoxydalbergione (**146**)	*D. baronii* (heartwood), *D. odorifera* (heartwood)	Donnelly et al., 1968; Chan et al., 1998
2′-Methoxyformononetin (**147**)	*D. parviflora* (heartwood)	Umehara et al., 2008
5-*O*-Methoxylatifolin (**148**)	*D. cochinchinensis* (heartwood)	Kuroyanagi et al., 1996
(3*R*)-4'-Methoxy-2',3,7-trihydroxyisoflavanone (**149**)	*D. odorifera* (heartwood)	Zhao et al., 2011
5′-Methoxy-vestitol (**150**)	*D. odorifera* (root, heartwood)	Yu et al., 2007; Choi et al., 2009
2′-*O*-Methyl-isoliquiritigenin (**151**)	*D. odorifera* (root, heartwood)	Yu et al., 2007; Park et al., 1995
3'-Methylorobol (**152**)	*D. parviflora* (heartwood)	Umehara et al., 2008
8-*O*-Methylretusin (**153**)	*D. retusa* (heartwood)	Jurd et al., 1972a
7-Methyltectorigenin 4'-*O*-[β-D-apiofuranosyl-(1->6)-β-D-glucopyranoside] (**154**)	*D. sissoo* (leaves)	Farag et al., 2001
7-*O*-Methyltectorigenin 4'-*O*-galactoside (**155**)	*D. spinosa* (leaves, stem-bark)	Narayanan et al., 1988
3'-*O*-Methylviolanone (**156**)	*D. odorifera* (heartwood)	Chan et al., 1998
Mucronulatol (**157**)	*D. odorifera* (heartwood), *D. oliveri*	Choi et al., 2009; Deesamer et al., 2007
Naringenin (**158**)	*D. stevensonii, D. odorifera* (heartwood)	Donnelly et al., 1973b; Hou et al., 2011
Neocandenatone (**159**)	*D. congestiflora* (heartwood)	Barragán-Huerta et al., 2004
Neokhriol A (**160**)	*D. parviflora* (heartwood)	Umehara et al., 2008
Nitiducarpin (**161**)	*D. nitidula* (bark)	Van Heerden et al., 1978
Nitiducol (**162**)	*D. nitidula* (bark)	Van Heerden et al., 1978
Nitidulan (**163**)	*D. nitidula* (bark)	Van Heerden et al., 1978
3,8-Nonadien-2-one (**164**)	*D. odorifera* (root)	Wang et al., 2000
Nordalbergin (**165**)	*D. sissoo* (stem bark, heartwood)	Mukerjee et al., 1971
Obtusafuran (**166**)	*D. retusa, D. louvelii* (heartwood)	Gregson et al., 1978a; Beldjoudi et al., 2003
Obtusaquinone (**167**)	*D. retusa* (heartwood)	Jurd et al., 1972b
Obtusastyrene (**168**)	*D. retusa* (heartwood)	Gregson et al., 1978a
Obtustyrene (**169**)	*D. retusa* (heartwood)	Gregson et al., 1978a
Odoratin (**170**)	*D. parviflora* (heartwood)	Umehara et al., 2008
Odoriflavene (**171**)	*D. odorifera* (root)	Yu et al., 2007
Olibergin A (**172**)	*D. oliveri* (stem-bark)	Ito et al., 2003b
Olibergin B (**173**)	*D. oliveri* (stem-bark)	Ito et al., 2003b
Onogenin (**174**)	*D. stevensonii* (bark, heartwood)	Donnelly et al., 1973b
Orobol 6-*C*-glucoside (**175**)	*D. monetaria* (bark)	Kawaguchi et al., 1998
Orobol 8-*C*-glucoside (**176**)	*D. monetaria* (bark)	Kawaguchi et al., 1998
Paniculatin (**177**)	*D. paniculata* (bark)	Narayanan et al., 1971
Parvifuran (**178**)	*D. parviflora* (heartwood)	Muangnoicharoen et al., 1981
4-Phenylcoumarin (**179**)	*D. baronii* (heartwood)	Donnelly et al., 1968
Pratensein (**180**)	*D. parviflora* (heartwood), *D. sissoo* (leaves)	Umehara et al., 2009; Dixit et al., 2012
Prunasin (**181**)	*D. spinosa* (leaves, stem-bark)	Narayanan et al., 1988
Prunetin 4'-*O*-[β-D-apiofuranosyl-(1→6)-β-D-glucopyranoside] (**182**)	*D. sissoo* (leaves)	Farag et al., 2001
Prunetin 4'-*O*-galactoside (**183**)	*D. spinosa* (leaves, stem-bark)	Narayanan et al., 1988
Prunetin 4'-*O*-glucoside (**184**)	*D. sissoo*	Farag et al., 2001
Pseudobaptigenin (**185**)	*D. spruceana* (wood)	Cook et al., 1978
Quinone (**186**)	*D. candenatensis* (heartwood)	Hamburger et al., 1987
Retusin (**187**)	*D. retusa* (heartwood)	Jurd et al., 1972a
(3*S*)-Sativanone (**188**)	*D. parviflora* (heartwood), *D. odorifera* (heartwood)	Umehara et al., 2009; Zhao et al., 2011
(3*S*)-Secundiflorol H (**189**)	*D. parviflora* (stem)	Umehara et al., 2009; Songsiang et al., 2011
Seshadrin (**190**)	*D. volubilis* (young branches)	Chawla et al., 1984a
Sissotrin (**191**)	*D. sissoides*	Ravi et al., 1990
Sitosterol (**192**)	*D. erruginea*	Donnelly et al. 1972
Sophorol (**193**)	*D. parviflora* (stems)	Songsiang et al., 2009
Spirolouveline (**194**)	*D. louvelii* (heartwood)	Beldjoudi et al., 2003
Stevenin (**195**)	*D. cultrata* (heartwood), *D.*	Donnelly et al. 1972;

	stevensonii (bark, heartwood)	Donnelly et al., 1973b
Stigmasterol (**196**)	*D. monetaria*	Khan et al., 1997
Stipulin (**197**)	*D. stipulacea* (root), *D. candenatensis* (heartwood)	Bhatt et al., 1992; Cheenpracha et al., 2012
Sulfuretin **(198)**	*D. odorifera* (heartwood)	Zhao et al., 2011
Tectoridin (**199**)	*D. volubilis* (flowers)	Chawla et al., 1976
Tectorigenin (**200**)	*D. odorifera* (heartwood), D. parviflora (heartwood)	Choi et al., 2009; Umehara et al., 2009
Tectorigenin 7-*O*-[β-D-apiofuranosyl-(1→6)-β-D-glucopyranoside] (**201**)	*D. sissoo* (leaves)	Farag et al., 2001
Tectorigenin 7-*O*-gentiobioside (**202**)	*D. sissoides* (stem-bark)	Khera et al., 1978
2′,4′,5′,6-Tetramethoxy-7-[(6-*O*-β-D-apiofuranosyl-β-D-glucopyranosyl)oxy]-isoflavone (**203**)	*D. vacciniifolia* (stem)	Innocent et al, 2010
4,2′,5′-Trihydroxy-4′-methoxychalcone (**204**)	*D. odorifera* (heartwood)	An et al., 2008
4′,5,7-Trihydroxy-3-methoxyflavone (**205**)	*D. odorifera* (root)	Wang et al., 2000
4′,5′,7-Trihydroxy-2′-methoxyisoflavone (**206**)	*D. nitidula* (heartwood)	Bekker et al., 2002
2′,3′,7-Trihydroxy-4′-methoxyisoflavanone (**207**)	*D. odorifera* (root)	Wang et al., 2000
(3*R*)-2',3',7-Trihydroxy-4'-methoxyisoflavanone (**208**)	*D. odorifera* (heartwood)	Zhao et al., 2011
(3*S*,6*R*,7*R*)-3,7,11-Trimethyl-3,6-epoxy-1,10-dodecadien-7-ol (**209**)	*D. odorifera* (essential oil)	Tao et al., 2010
(3*S*,6*S*,7*R*)-3,7,11-Trimethyl-3,6-epoxy-1,10-dodecadien-7-ol (**210**)	*D. odorifera* (essential oil)	Tao et al., 2010
(6a*R*, 11a*R*)-Vesticarpan (**211**)	*D. parviflora* (heartwood)	Umehara et al., 2008
Vestitol (**212**)	*D. odorifera* (root, heartwood)	Wang et al., 2000; Zhao et al., 2011
Vestitol-(5'→2)-2'-hydroxyformononetin (**213**)	*D. nitidula* (heartwood)	Bezuidenhoudt et al., 1988
Violanone (**214**)	*D. odorifera* (heartwood)*, D. oliveri*	Liu et al., 2005; Deesamer et al., 2007
Violastyrene (**215**)	*D. miscolobium* (heartwood)	Gregson et al., 1978b
Vestitone (**216**)	*D. odorifera* (heartwood)	Liu et al., 2005
(3*R*)-Vestitone (**217**)	*D. odorifera* (heartwood)	Zhao et al., 2011
Volubilin (**218**)	*D. volubilis* (flowers)	Chawla et al., 1974
Volubilinin (**219**)	*D. volubilis* (flowers)	Chawla et al., 1976
Volubinol (**220**)	*D. volubilis* (non green branches)	Chawla et al., 1984c
Volubolin (**221**)	*D. volubilis* (young branches)	Chawla et al., 1983
Voludal (**222**)	*D. volubilis* (non green branches)	Chawla et al., 1984b
Xenognosin B (**223**)	*D. odorifera* (heartwood)	Chan et al., 1998

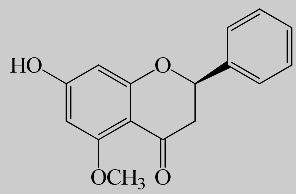
Table 4. Bioactive compounds isolated from various species of genus *Dalbergia*.

Bioactive Compound (Structure Number)	Bioactivity	Plant Name (Part)	Reference
Biochanin A (**2**)	Anti-inflammatory; osteogenic, cytotoxic	*D. sissoides* (flower), *D. sissoo* (leaves), *D. parviflora* (heartwood)	Kavimani et al., 1997; Dixit et al., 2012; Umehara et al., 2009
Biochanin A 7-*O*-glucoside (**5**)	Osteogenic	*D. sissoo* (leaves)	Dixit et al., 2012
Bowdichione (**7**)	Anti-inflammatory	*D. odorifera* (heartwood)	Chan et al., 1998
Butein (**8**)	Anti-inflammatory, antioxidant	*D. odorifera* (heartwood)	Chan et al., 1998; Cheng et al., 1998
(3*R*)-Calussequinone (**11**)	Cytotoxic	*D. odorifera* (heartwood)	Choi et al., 2009
Calycosin (**12**)	Anti-androgen	*D. cochinchinensis* (heartwood)	Kuroyanagi et al., 1996
Carthamidin (**26**)	Antibacterial	*D. odorifera*	Zhao et al., 2011

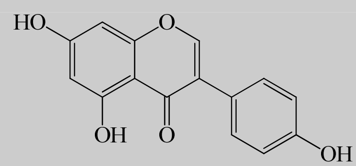
		(heartwood)	
Caviunin 7-*O*-[β-D-apiofuranosyl-(1→6)-β-D-glucopyranoside] (**28**)	Osteogenic	*D. sissoo* (leaves)	Dixit et al., 2012
Cearoin (**31**)	Anti-allergic, anti-inflammatory	*D. odorifera* (heartwood)	Chan et al., 1998
Dalberatins A (**34**)	Cancer chemopreventive	*D. cultrata* and *D. nigrescens* (stem-bark)	Ito et al., 2003a
Dalberatins B (**35**)	Cancer chemopreventive	*D. cultrata* and *D. nigrescens* (stem-bark)	Ito et al., 2003a
Dalberatins C (**36**)	Cancer chemopreventive	*D. cultrata* and *D. nigrescens* (stem-bark)	Ito et al., 2003a
Dalberatins D (**37**)	Cancer chemopreventive	*D. cultrata* and *D. nigrescens* (stem-bark)	Ito et al., 2003a
Dalberatins E (**38**)	Cancer chemopreventive	*D. cultrata* and *D. nigrescens* (stem-bark)	Ito et al., 2003a
R(+)-Dalbergiphenol (**39**)	Protective in oxidative injury	*D. odorifera* (heartwood)	An et al., 2008
Darbergiol (**66**)	Anti-androgen	*D. cochinchinensis* (heartwood)	Kuroyanagi et al., 1996
2,5-Dihydroxy-4-methoxybenzophenone (**77**)	Anti-androgen	*D. cochinchinensis* (heartwood)	Kuroyanagi et al., 1996
2,4-Dihydroxy-5-methoxybenzophenone (**78**)	Antioxidant	*D. odorifera* (root)	Wang et al., 2000
7,4′-Dihydroxy-3′-methoxyisoflavone (**80**)	Antiplasmodial	*D. louvelii* (heartwood)	Beldjoudi et al., 2003
(2*S*)-6,4′-Dihydroxy-7-methoxyflavan (**81**)	Protective in oxidative injury	*D. odorifera* (heartwood)	An et al., 2008
6,4′-Dihydroxy-7-methoxyflavanone (**82**)	Protective in oxidative injury	*D. odorifera* (heartwood)	An et al., 2008
6,2'-Dimethoxy-7,4'-dihydroxyisoflavone (**85**)	Cytotoxic	*D. vacciniifolia*	Innocent et al., 2010
Eriodictoyl (**91**)	Antioxidant	*D. odorifera* (heartwood)	Hou et al., 2011
Formononetin (**92**)	Antigiarrdial, cytotoxic	*D. frutescans* (bark), *D. odorifera* (heartwood)	Khan et al., 2000; Choi et al., 2009
Genstein (**95**)	Osteogenic, cytotoxic	*D. sissoo* (leaves), *D. parviflora* (heartwood)	Dixit et al., 2012; Umehara et al., 2009
Hexadecanoic acid, ethyl ester (**100**)	Antioxidant	*D. odorifera* (root)	Wang et al., 2000
Hexanoic acid, 2-propenyl ester (**101**)	Antioxidant	*D. odorifera* (root)	Wang et al., 2000
2-Hydroxy-3,4-dimethoxybenzaldehyde (**103**)	Cytotoxic	*D. odorifera* (heartwood)	Choi et al., 2009
9-Hydroxy-6,7-dimethoxydalbergiquinol (**104**)	Protective in oxidative injury	*D. odorifera* (heartwood)	An et al., 2008
Hydroxyobtustyrene (**108**)	*D. odorifera* (heartwood)	Choi et al., 2009	
Isoliquiritigenin (**116**)	Antibacterial, antiplasmodial, anti-androgen	*D. louvelii* (heartwood), *D. odorifera* (heartwood), *D. cochinchinensis* (heartwood)	Beldjoudi et al., 2003; Zhao et al., 2011; Kuroyanagi et al., 1996
Isoparvifuran (**117**)	Protective in oxidative injury	*D. odorifera* (heartwood)	An et al., 2008
Koparin (**127**)	Anti-inflammatory	*D. odorifera* (heartwood)	Chan et al., 1998
R(-)-Latifolin (**129**)	Protective in oxidative injury, anti-androgen	*D. odorifera* (heartwood), *D. cochinchinensis* (heartwood)	An et al., 2008; Kuroyanagi et al., 1996

Liquiritigenin (**134**)	Antibacterial, cytotoxic, anti-androgen	*D. odorifera* (heartwood), *D. cochinchinensis* (heartwood)	Zhao et al., 2011; Choi et al., 2009; Kuroyanagi et al., 1996
(–)-Medicarpin (**137**)	Antioxidant, cytotoxic	*D. odorifera* (root, heartwood)	Wang et al., 2000; Choi et al., 2009
(+)-Medicarpin (**138**)	Antifungal	*D. congestiflora* (heartwood)	Martínez-Sotres et al., 2012
3´-Methoxydaidzein (**144**)	Antioxidant	*D. odorifera* (root)	Wang et al., 2000
R(+)-4-Methoxydalbergione (**145**)	Protective in oxidative injury, antiplasmodial, anti-androgen	*D. odorifera* (heartwood); *D. cochinchinensis* (heartwood)	An et al., 2008; Beldjoudi et al., 2003; Kuroyanagi et al., 1996
(*S*)-4-Methoxydalbergione (**146**)	Anti-allergic, anti-inflammatory	*D. odorifera* (heartwood)	Chan et al., 1998
2′-Methoxyformononetin (**147**)	Cytotoxic	*D. parviflora* (heartwood)	Umehara et al., 2009
5-*O*-Methoxylatifolin (**148**)	Anti-androgen	*D. cochinchinensis* (heartwood)	Kuroyanagi et al., 1996
(3*R*)-4'-Methoxy-2',3,7-trihydroxyisoflavanone (**149**)	Antibacterial	*D. odorifera* (heartwood)	Zhao et al., 2011
(3*R*)-5′-methoxyvesitol (**150**)	Cytotoxic	*D. odorifera* (heartwood)	Choi et al., 2009
2′-*O*-Methyl-isoliquiritigenin (**151**)	Cytotoxic	*D. odorifera* (heartwood)	Park et al., 1995
3'-*O*-Methylviolanone (**156**)	Anti-inflammatory	*D. odorifera* (heartwood)	Chan et al., 1998
Mucronulatol (**157**)	Cytotoxic, antifungal	*D. odorifera* (heartwood), *D. oliveri*	Deesamer et al., 2007; Choi et al., 2009
Naringenin (**158**)	Antioxidant	*D. odorifera* (heartwood)	Hou et al., 2011
3,8-Nonadien-2-one (**164**)	Antioxidant	*D. odorifera* (root)	Wang et al., 2000
Obtusafuran (**166**)	Antiplasmodial	*D. louvelii* (heartwood)	Beldjoudi et al., 2003
Orobol 6-*C*-glucoside (**175**)	Immunomodulating	*D. monetaria* (bark)	Kawaguchi et al., 1998
Orobol 8-*C*-glucoside (**176**)	Immunomodulating	*D. monetaria* (bark)	Kawaguchi et al., 1998
Pratensein (**180**)	Osteogenic	*D. sissoo* (leaves)	Dixit et al., 2012
Sativanone (**188**)	Antibacterial	*D. odorifera* (heartwood)	Zhao et al., 2011
(3*S*)-Secundiflorol H (**189**)	Cytotoxic	*D. parviflora* (stem)	Songsiang et al., 2011
Sulfuretin (**198**)	Antibacterial	*D. odorifera* (heartwood)	Zhao et al., 2011
Tectorigenin (**200**)	Cytotoxic	*D. odorifera* (heartwood), *D. parviflora* (heartwood)	Choi et al., 2009; Umehara et al., 2009
4,2′,5′-Trihydroxy-4′-methoxychalcone (**204**)	Protective in oxidative injury	*D. odorifera* (heartwood)	An et al., 2008
4´,5,7-Trihydroxy-3-methoxyflavone (**205**)	Antioxidant	*D. odorifera* (root)	Wang et al., 2000
2´,3´,7-Trihydroxy-4´-methoxyisoflavanone (**207**)	Antioxidant	*D. odorifera* (root)	Wang et al., 2000
(3*R*)-2',3',7-Trihydroxy-4'-methoxyisoflavanone (**208**)	Antibacterial	*D. odorifera* (heartwood)	Zhao et al., 2011
(3*S*,6*R*,7*R*)-3,7,11-Trimethyl-3,6-epoxy-1,10-dodecadien-7-ol (**209**)	Anti-thrombotic, anti-platelet	*D. odorifera* (essential oil)	Tao et al., 2010

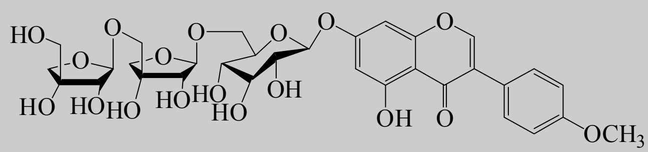
(3*S*,6*S*,7*R*)-3,7,11-Trimethyl-3,6-epoxy-1,10-dodecadien-7-ol (**210**)	Anti-thrombotic, anti-platelet	*D. odorifera* (essential oil)	Tao et al., 2010
Vestitol (**212**)	Antioxidant, antibacterial	*D. odorifera* (root, heartwood)	Wang et al., 2000; Zhao et al., 2011
(3*R*)-Vestitone (**217**)	Antibacterial	*D. odorifera* (heartwood)	Zhao et al., 2011
Violanone (**214**)	Antifungal	*D. oliveri*	Deesamer et al., 2007
Xenognosin B (**223**)	Anti-inflammatory	*D. odorifera* (heartwood)	Chan et al., 1998



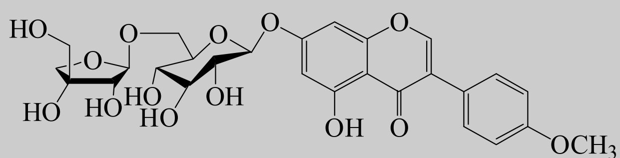
Alpinetin (**1**)



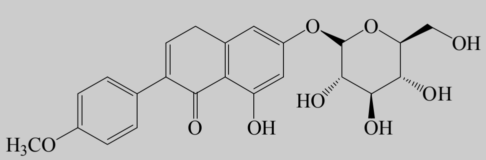
Biochanin A (**2**)



Biochanin A 7-*O*-[β-D-apiofuranosyl-(1→5)-β-D-apiofuranosyl-(1→6)-β-D-glucopyranoside] (**3**)



Biochanin A 7-*O*-apiosyl-(1→6)-glucoside (**4**)



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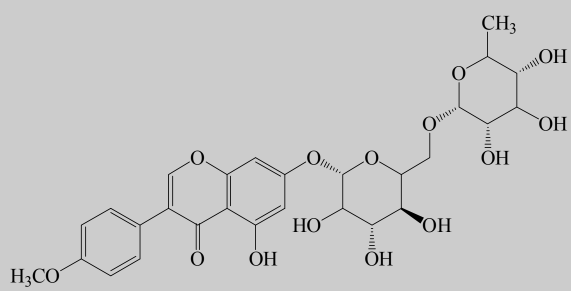
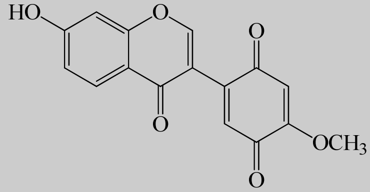
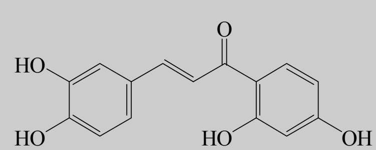


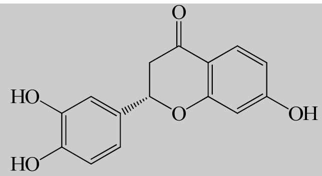
Biochanin A 7-*O*-rutinoside (**6**)



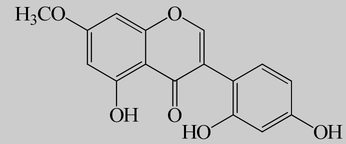
Bowdichione (**7**)



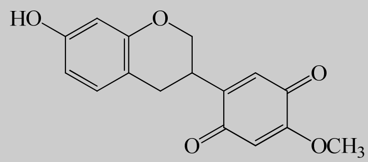
Butein (**8**)



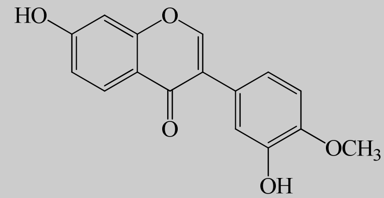
Butin (**9**)



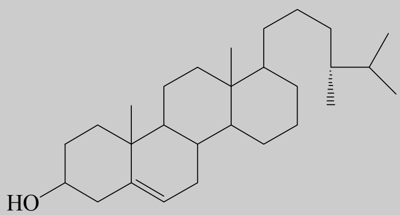
Cajanin (**10**)



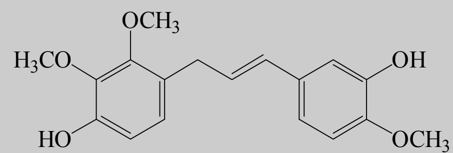
(3*R*)-Calussequinone (**11**)



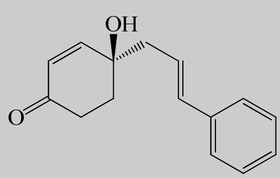
Calycosin (**12**)



Campesterol (**13**)



Candenatenin A (**14**)



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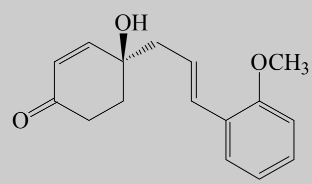

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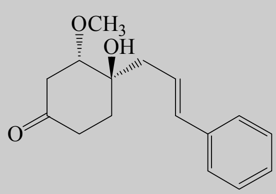
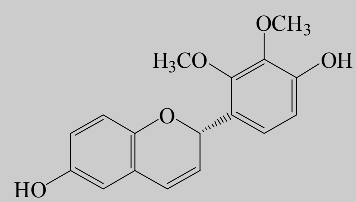
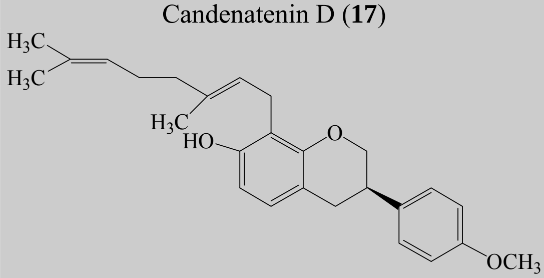


Candenatenin D (**17**)



Candenatenin E (**18**)



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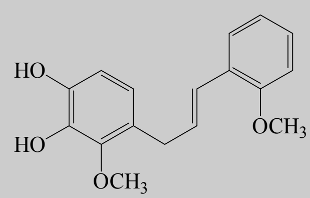
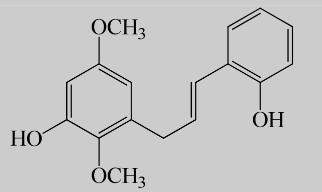
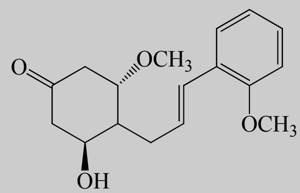


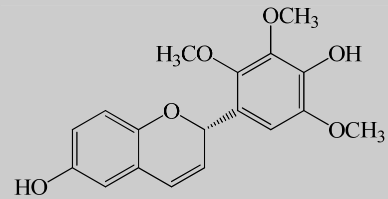
Candenatenin G (**20**)



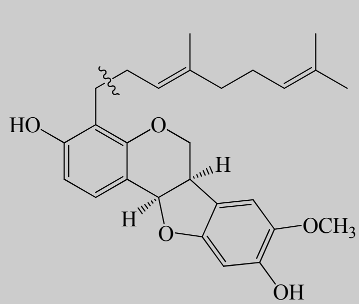
Candenatenin H (**21**)



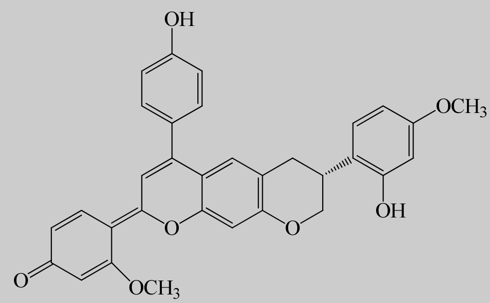
Candenatenin I (**22**)



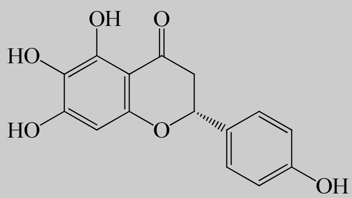
Candenatenin J (**23**)



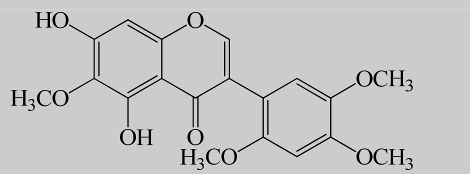
Candenatenin K (**24**)



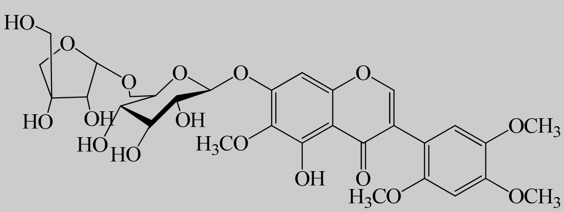
Candenatone (**25**)



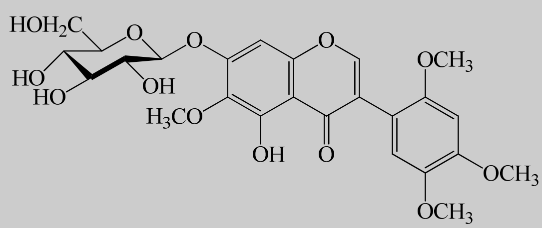
Carthamidin (**26**)



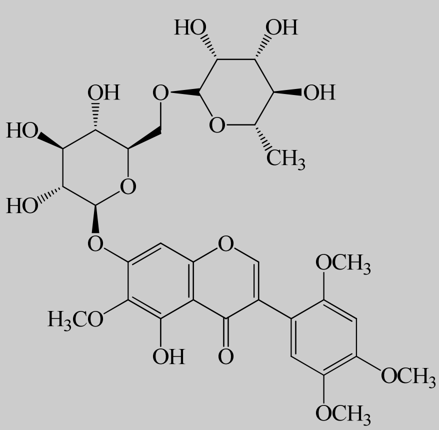
Cavunin (**27**)



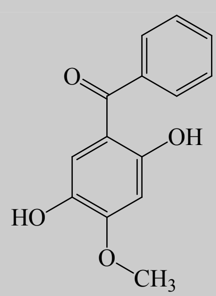
Caviunin 7-*O*-[*β*-D-apiofuranosyl-(1→6)-*β*-D-glucopyranoside] (**28**)



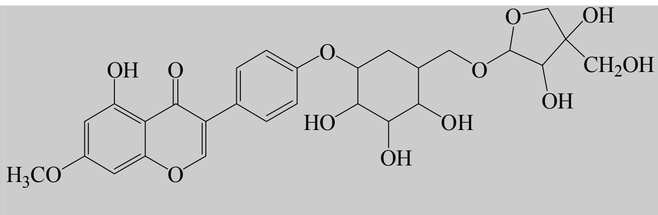
Caviunin 7-*O*-glucoside (**29**)



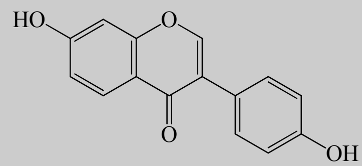
Caviunin 7-O-rhamnoglucoside (**30**)



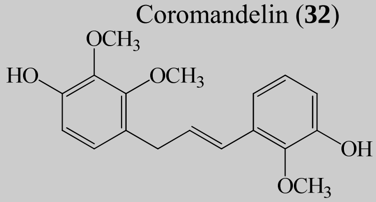
Cearoin (**31**)



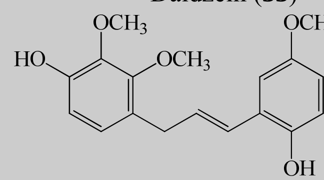
Coromandelin (**32**)



Daidzein (**33**)



Dalberatins A (**34**)



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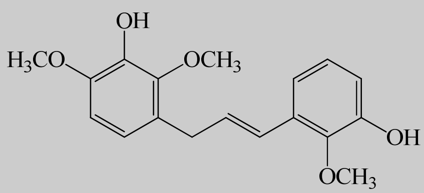
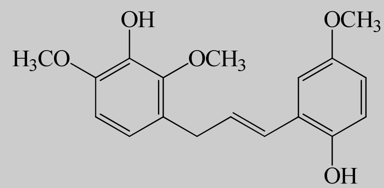
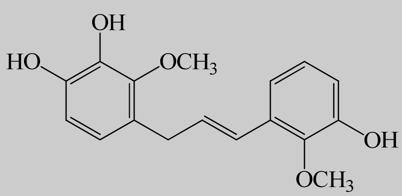


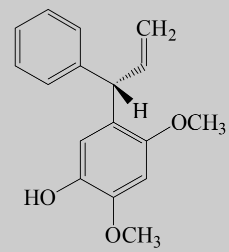
Dalberatins C (**36**)



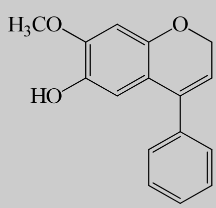
Dalberatins D (**37**)



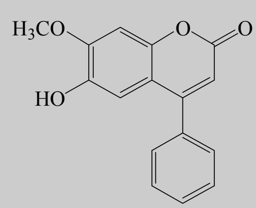
Dalberatins E (**38**)



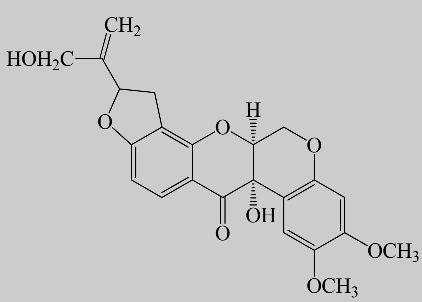
R(+)-Dalbergiphenol (**39**)



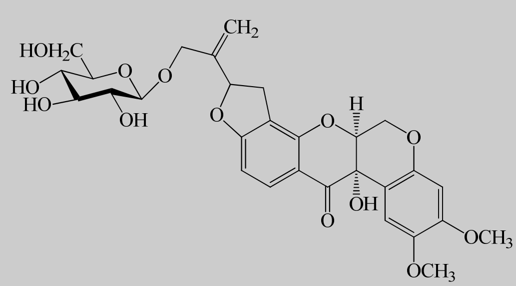
Dalbergichromene (**40**)



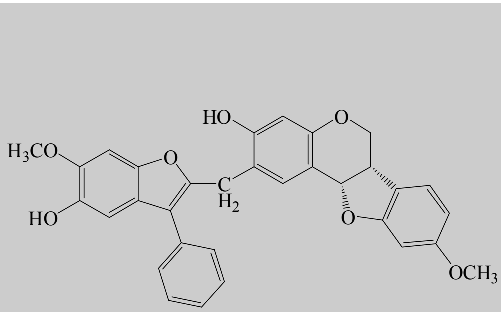
Dalbergin (**41**)



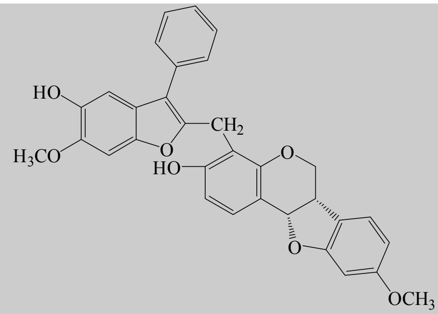
Dalbinol (**42**)



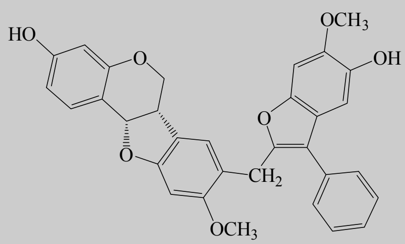
Dalbinol *O*-glucoside (**43**)



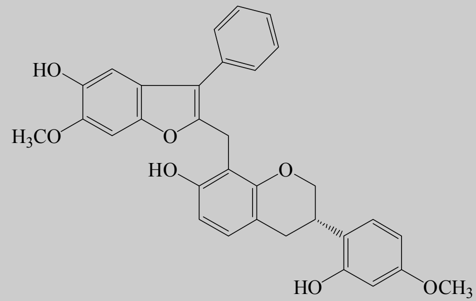
Daljanelin A (**44**)



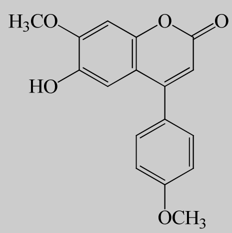
Daljanelin B (**45**)



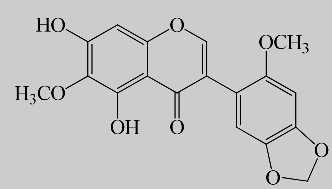
Daljanelin C (**46**)



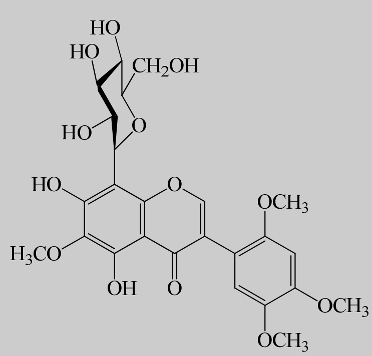
Daljanelin D (**47**)



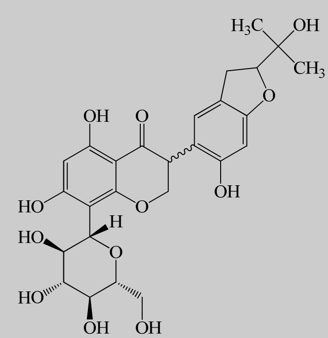
Dalnigrin (**48**)



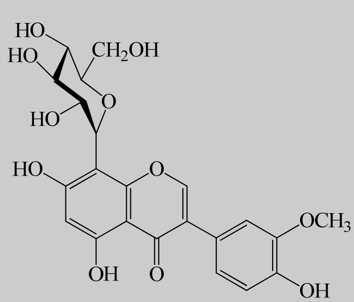
Dalpalatin (**49**)



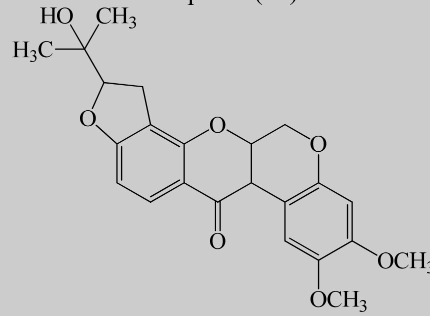
Dalpaniculin (**50**)



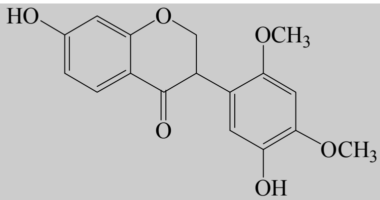
Dalpanin (**51**)



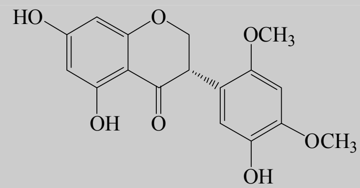
Dalpanitin (**52**)



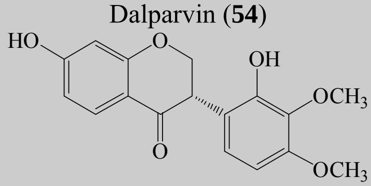
Dalpanol (**53**)



Dalparvin (**54**)



Dalparvin A (**55**)



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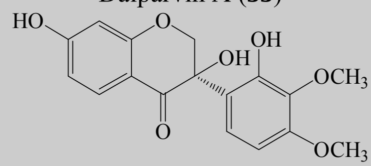
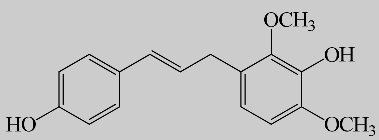
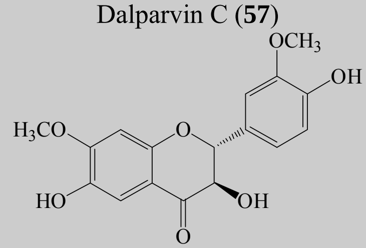


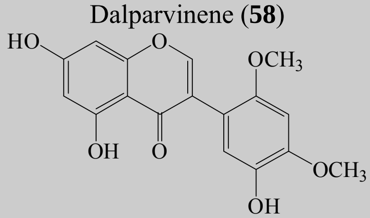
Dalparvin C (**57**)



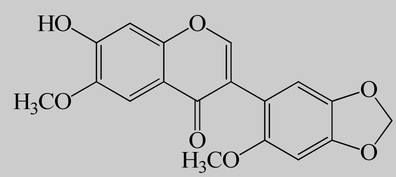
Dalparvinene (**58**)



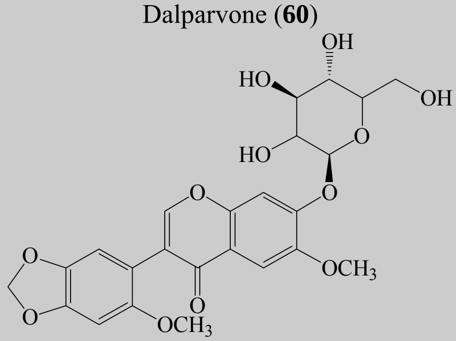
Dalparvinol C (**59**)



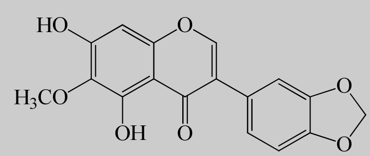
Dalparvone (**60**)



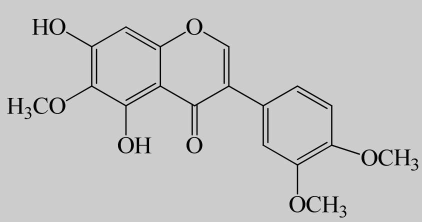
Dalpatein (**61**)



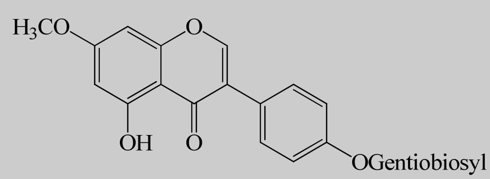
Dalpatin (**62**)



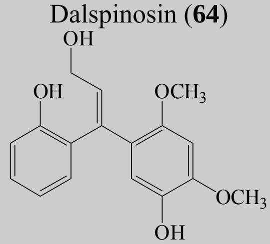
Dalspinin (**63**)



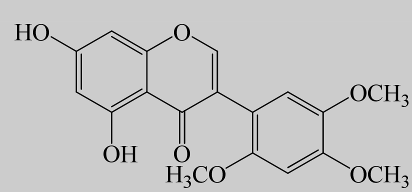
Dalspinosin (**64**)



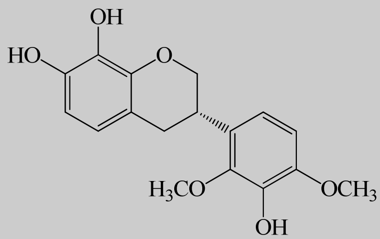
Dalsympathetin (**65**)



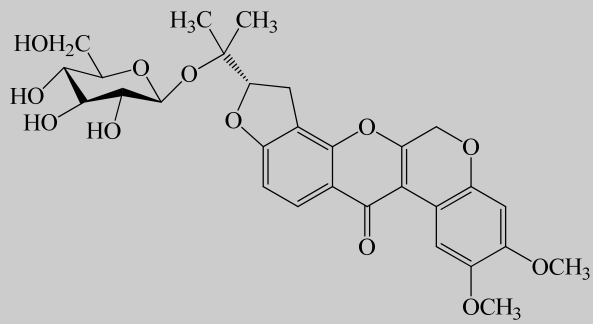
Darbergiol (**66**)



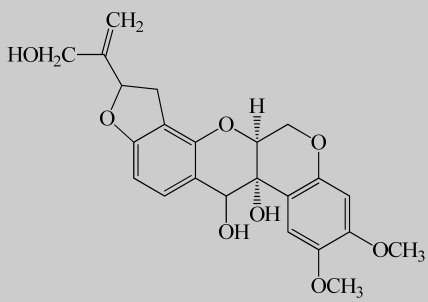
7-Demethylrobustigenin (**67**)



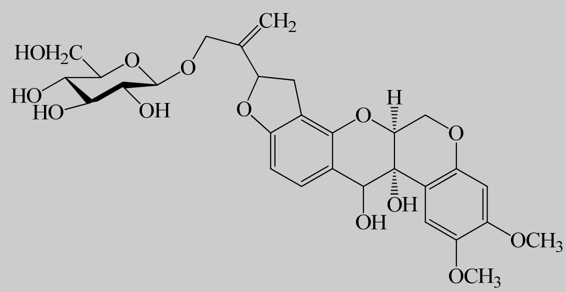
8-Demethylduartin (**68**)



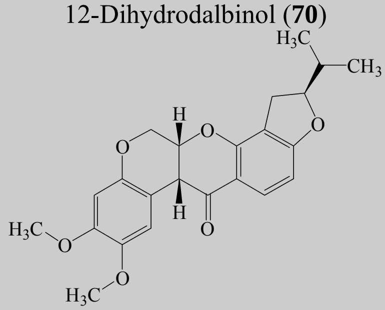
Dehydrodalpanol *O*-glucoside (**69**)



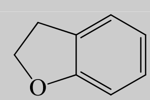
12-Dihydrodalbinol (**70**)



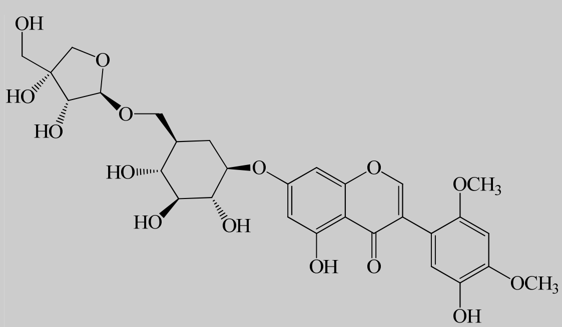
12-Dihydrodalbinol-*O*-glucoside (**71**)



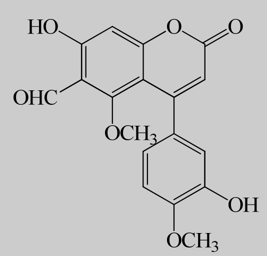
Dihydrorotenone (**72**)



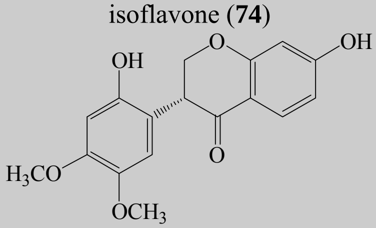
2,3-Dihydrobenzofuran (**73**)



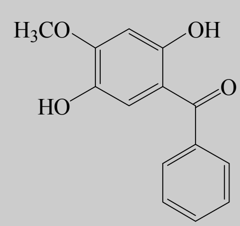
5,5′-Dihydroxy-2′,4′-dimethoxy-7-[(6-*O*-β-D-apiofuranosyl-β-D-glucopyranosyl)-oxy]-isoflavone (**74**)



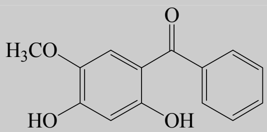
7,3’-Dihydroxy-5,4’-dimethoxy-6-formyl-4-phenylcoumarin (**75**)



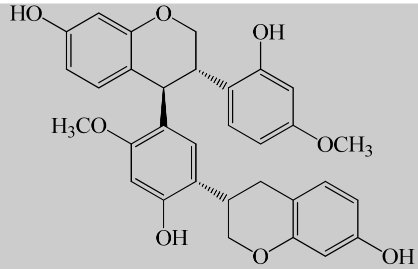
(3*R*)-7,2'-Dihydroxy-4',5'-dimethoxyisoflavanone (**76**)



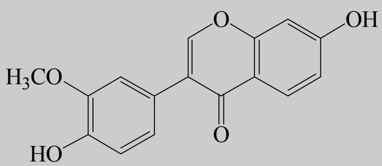
2,5-Dihydroxy-4-methoxybenzophenone (**77**)



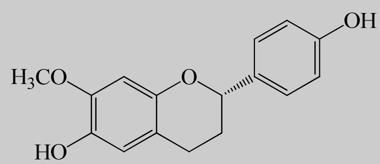
2,4-Dihydroxy-5-methoxybenzophenone (**78**)



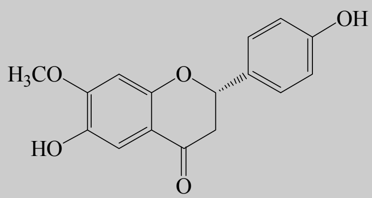
(3*S*,4*S*)-3,4-*trans*-2',7-Dihydroxy-4'-methoxy-4-[(3*S*)-2',7-dihydroxy-4'-methoxyisoflavan-5'-yl]isoflavan (**79**)



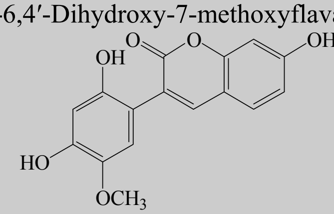
7,4'-Dihydroxy-3'-methoxyisoflavone (**80**)



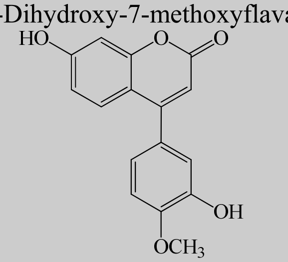
(2*S*)-6,4′-Dihydroxy-7-methoxyflavan (**81**)



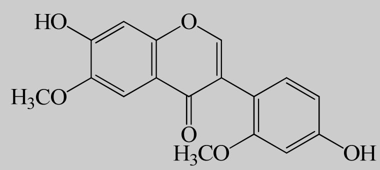
(2*S*)-6,4′-Dihydroxy-7-methoxyflavan (**82**)



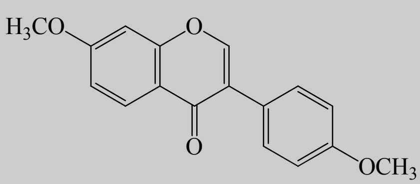
3-(2,4-Dihydroxy-5-methoxy)phenyl-7-hydroxycoumarin (**83**)



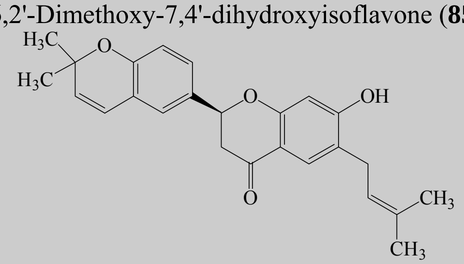
7,3’-Dihydroxy-4’-methoxy-4-phenylcoumarin (**84**)



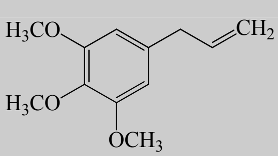
6,2'-Dimethoxy-7,4'-dihydroxyisoflavone (**85**)



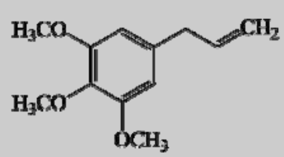
Di-*O*-methyldaidzein (**86**)



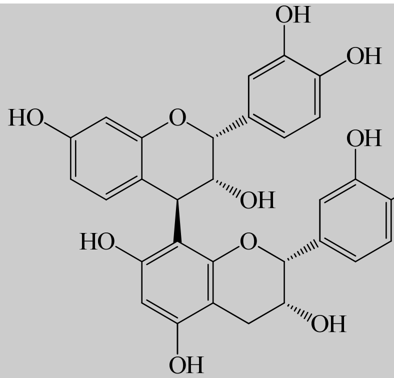
Dinklagin A (**87**)



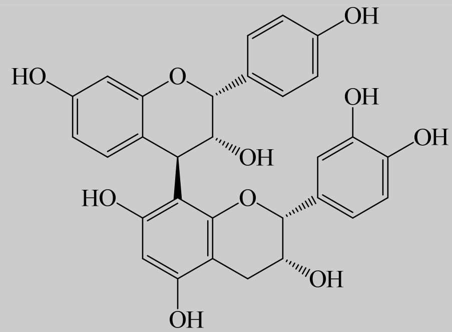
Elemicin (**88**)



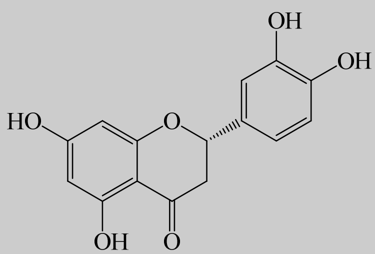
Elemicin (**89**)



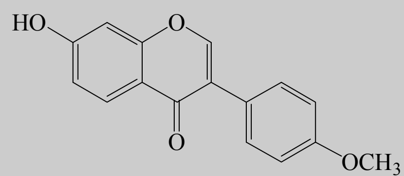
Epifisetinidol-(4β→8)-epicatechin (**89**)



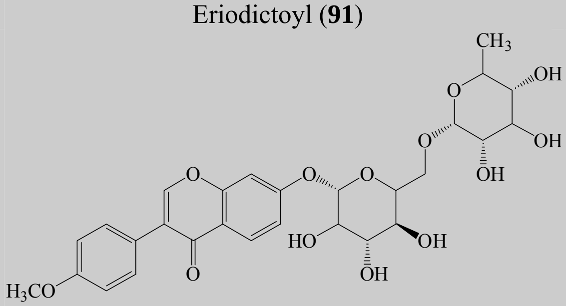
Epiguibourtinidol-(4α→8)-epicatechin (**90**)



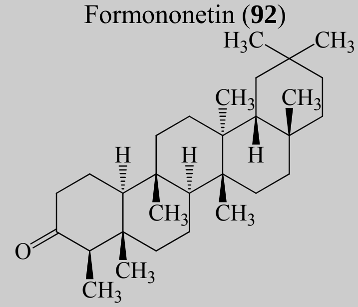
Eriodictoyl (**91**)



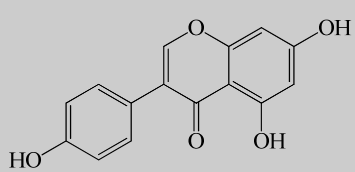
Formononetin (**92**)



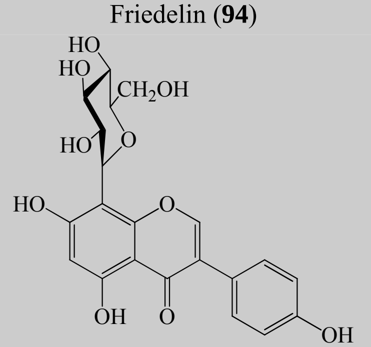
Formononetin 7-*O*-rutinoside (**93**)



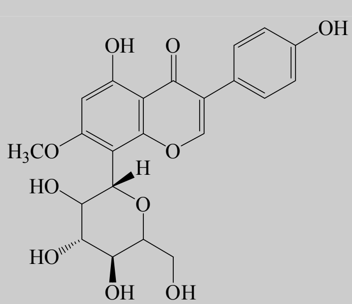
Friedelin (**94**)



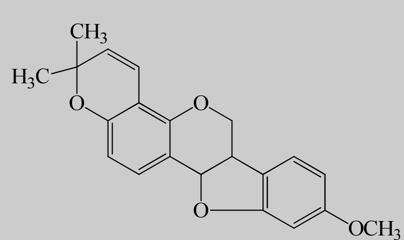
Genstein (**95**)



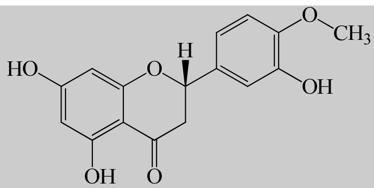
Genistein 8-*C*-glucoside (**96**)



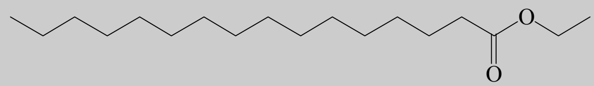
8-*C*-glucosylprunetin (**97**)



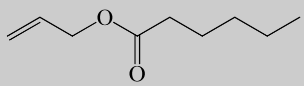
Hemileiocarpin (**98**)



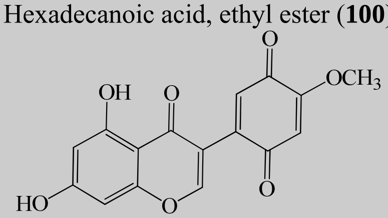
Hesperetin (**99**)



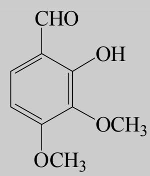
Hexadecanoic acid, ethyl ester (**100**)



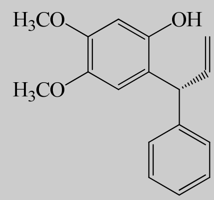
Hexanoic acid, 2-Propenylester (**101**)



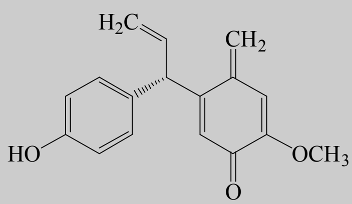
5-Hydroxybowdichione (**102**)



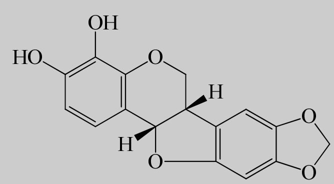
2-Hydroxy-3,4-dimethoxybenzaldehyde (**103**)



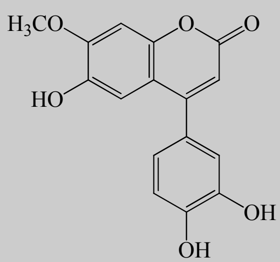
9-Hydroxy-6,7-dimethoxydalbergiquinol (**104**)



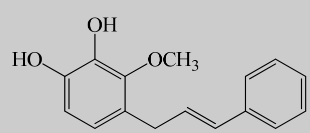
(*S*)-4′-Hydroxy-4-methoxydalbergione (**105**)



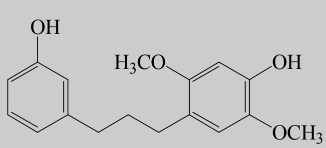
4-Hydroxymaackiain (**106**)



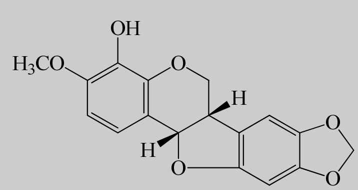
3'-Hydroxymelanettin (**107**)



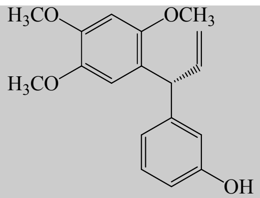
Hydroxyobtustyrene (**108**)



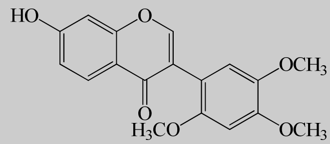
1-(3-Hydroxyphenyl)-3-(4-hydroxy-2,5-dimethoxyphenyl)propane (**109**)



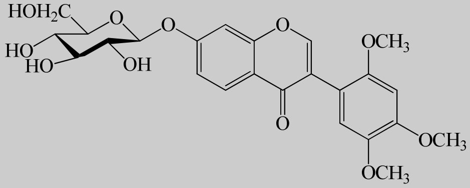
4-Hydroxypterocarpin (**110**)



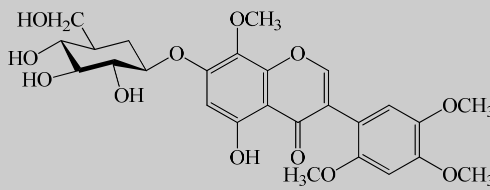
3'-Hydroxy-2,4,5-trimethoxydalbergiquinol (**111**)



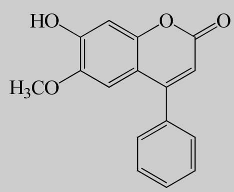
7-Hydroxy-2',4',5'-trimethoxyisoflavone (**112**)



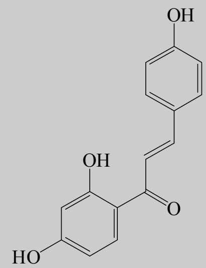
7-Hydroxy-2',4',5'-trimethoxyisoflavone 7-*O*-glucoside (**113**)



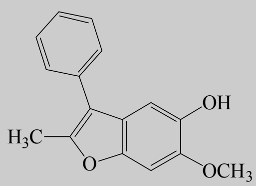
Isocavuinin-7-*O*-glucoside (**114**)



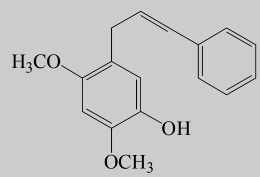
Isodalbergin (**115**)



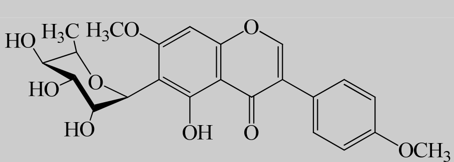
Isoliquiritigenin (**116**)



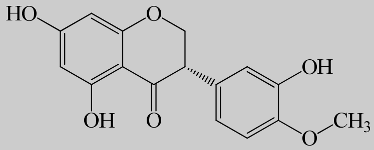
Isoparvifuran (**117**)



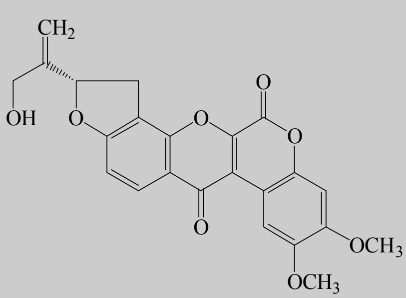
Isoviolastyrene (118)



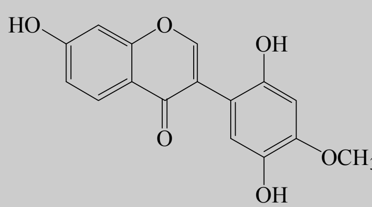
Isovolubilin (**119**)



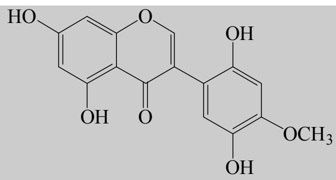
Kenusanone G (**120**)



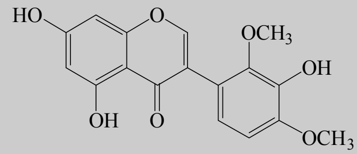
6-Ketodehydroamorphigenin (**121**)



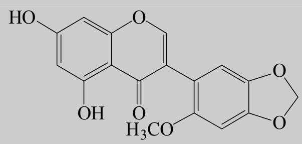
Khrinone A (**122**)



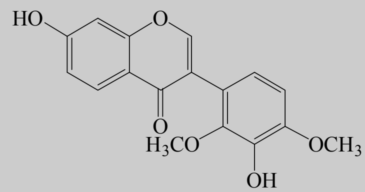
Khrinone B (**123**)



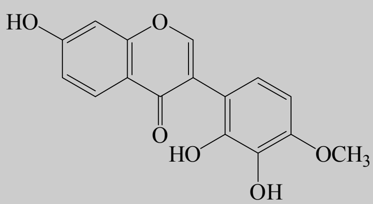
Khrinone C (**124**)



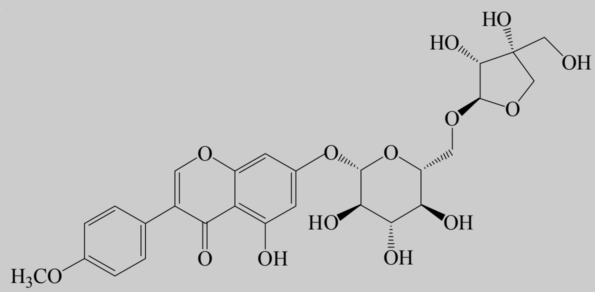
Khrinone D (**125**)



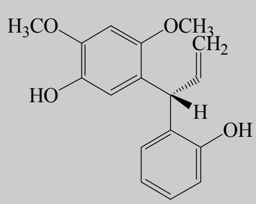
Khrinone E (**126**)



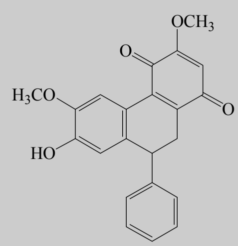
Koparin (**127**)



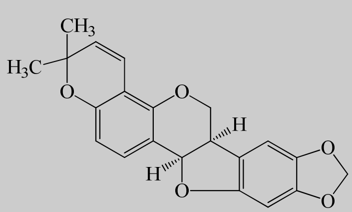
Lanceolarin (**128**)



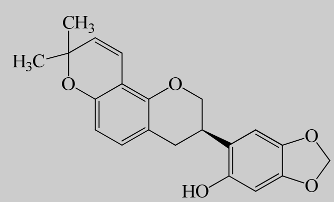
Latifolin (**129**)



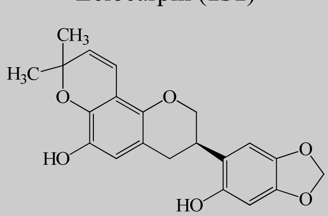
Latinone (**130**)



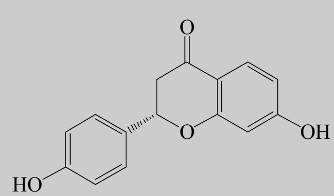
Leiocarpin (**131**)



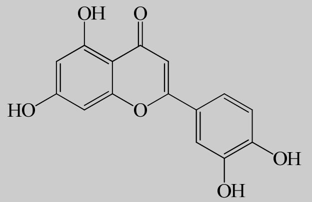
Leiocin (**132**)



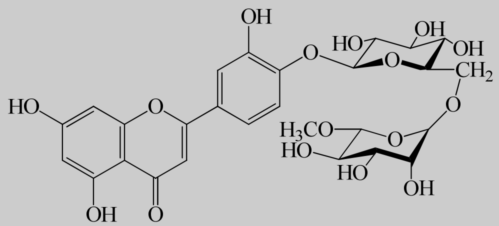
Leiocinol (**133**)



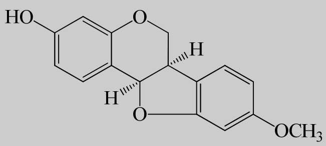
Liquiritigenin (**134**)



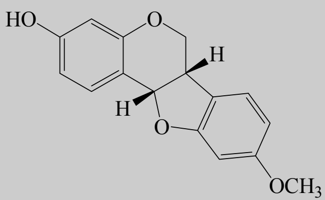
Luteolin (**135**)



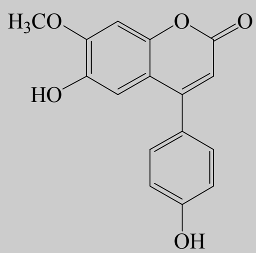
Luteolin -4'-rutinoside (**136**)



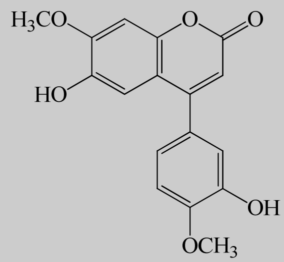
(-)-Medicarpin (**137**)



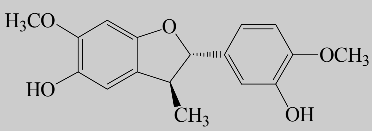
(+)-(6a*S*,11a*S*)-Medicarpin (**138**)



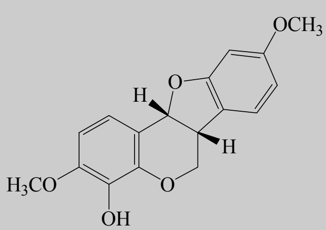
Melanettin (**139**)



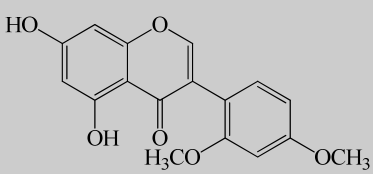
Melannein (**140**)



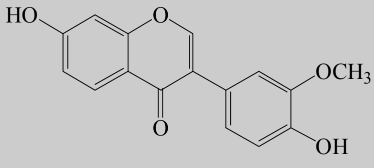
Melanoxin (**141**)



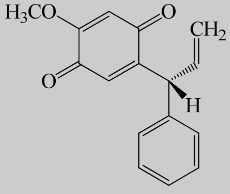
Melilotocarpan A (**142**)



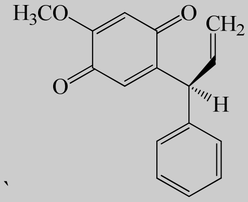
2'-Methoxybiochanin A (**143**)



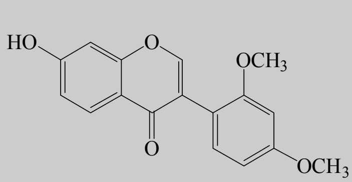
3′-Methoxydaidzein (**144**)



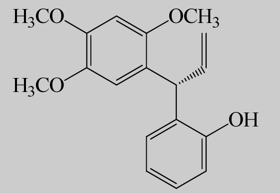
R(+)-4-Methoxydalbergione (**145**)



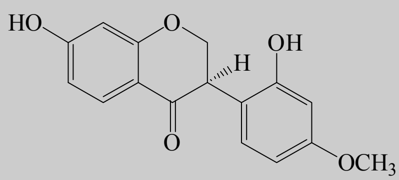
(*S*)-4-Methoxydalbergione (**146**)



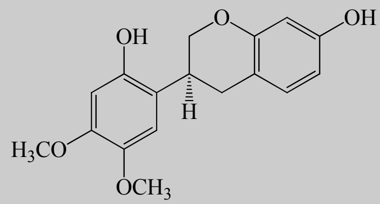
2′-Methoxyformononetin (1**47**)



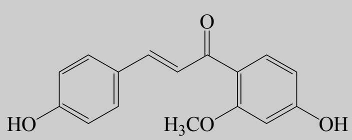
5-*O*-Methoxylatifolin (**148**)



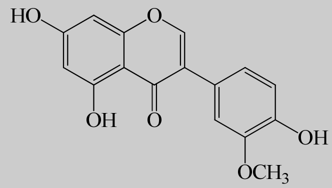
(3*R*)-4'-Methoxy-2',3,7-trihydroxyisoflavanone (**149**)



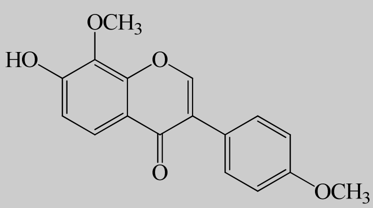
5′-Methoxy-vestitol (**150**)



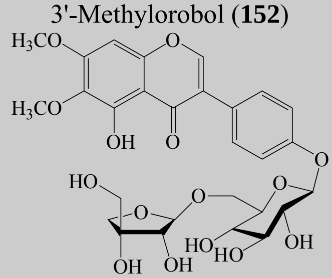
2′-*O*-methyl-isoliquiritigenin (**151**)



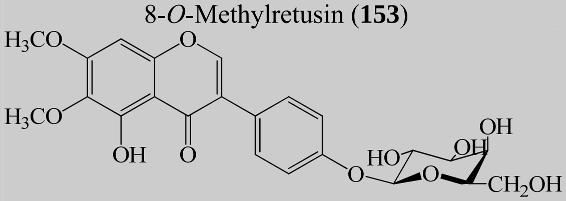
3'-Methylorobol (**152**)



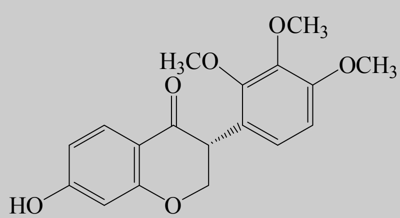
8-*O*-Methylretusin (**153**)



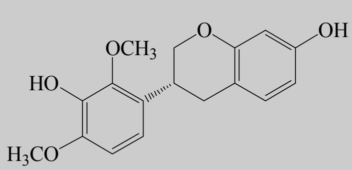
7-Methyltectorigenin 4'-*O*-[β-D-apiofuranosyl-(1→6)-β-D-glucopyranoside] (**154**)



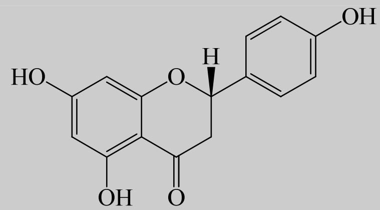
7-*O*-Methyltectorigenin 4'-*O*-galactoside (**155**)
)



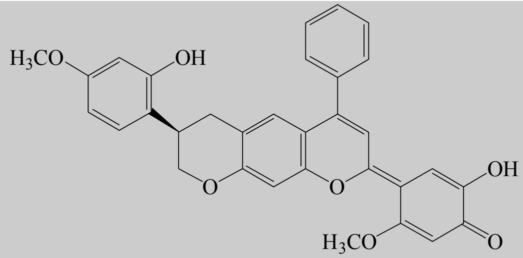
3'-*O*-Methylviolanone (**156**)



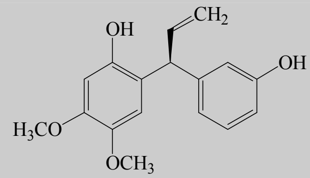
Mucronulatol (**157**)



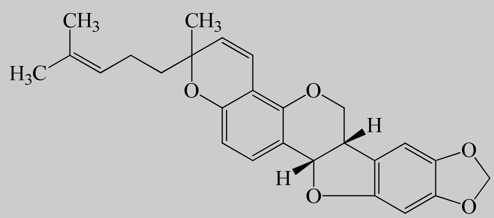
Naringenin (**158**)



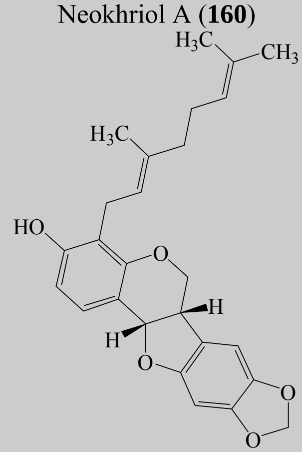
Neocandenatone (**159**)



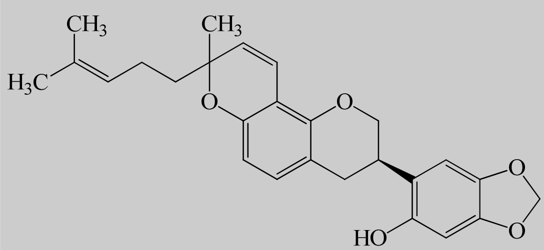
Neokhriol A (**160**)



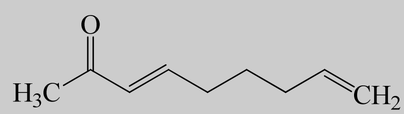
Nitiducarpin (**161**)



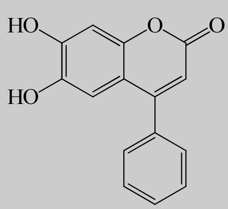
Nitiducol (**162**)



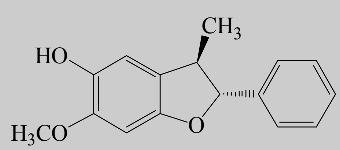
Nitidulan (**163**)



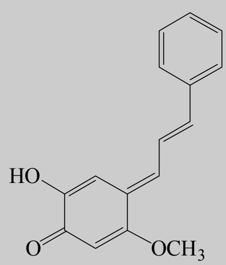
3,8-Nonadien-2-one (**164**)



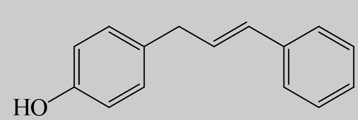
Nordalbergin (**165**)



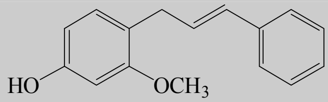
Obtusafuran (**166**)



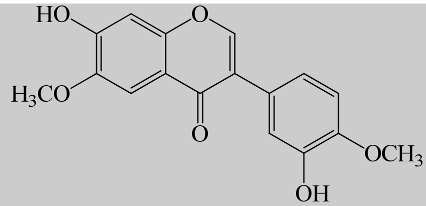
Obtusaquinone (**167**)



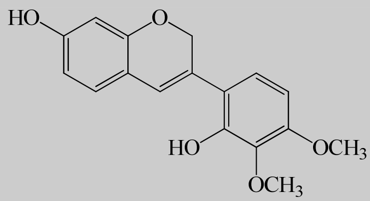
Obtusastyrene (**168**)



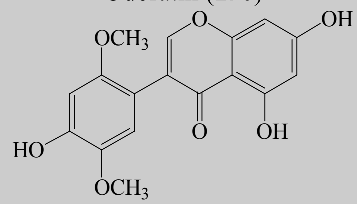
Obtustyrene (**169**)



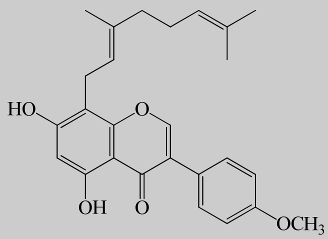
Odoratin (**170**)



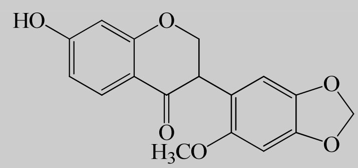
Odoriflavene (**171**)



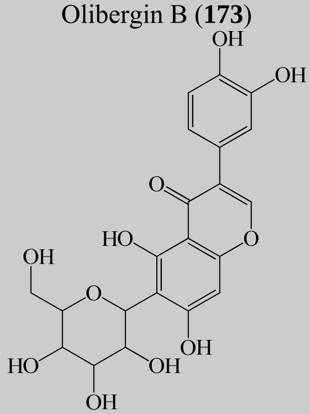
Olibergin A (**172**)



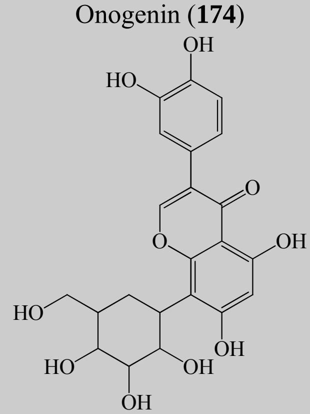
Olibergin B (**173**)



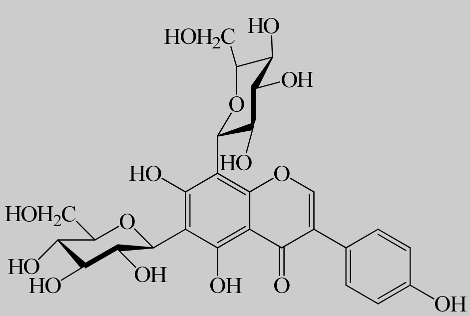
Onogenin (**174**)



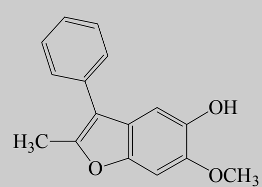
Orobol 6-*C*-glucoside (**175**)



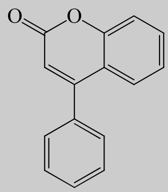
Orobol 8-*C*-glucoside (**176**)



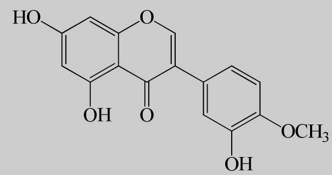
Paniculatin (**177**)



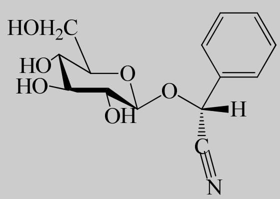
Parvifuran (**178**)



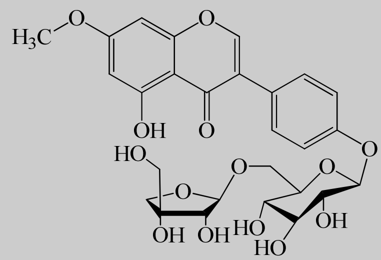
4-Phenylcoumarin (**179**)



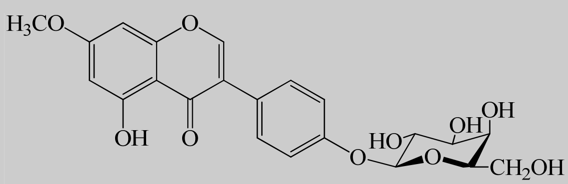
Pratensein (**180**)



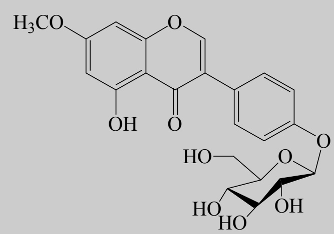
Prunasin (**181**)



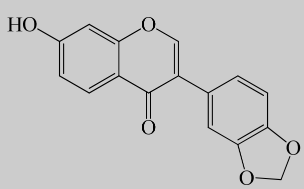
Prunetin 4'-*O*-[β-D-apiofuranosyl-(1→6)-β-D-glucopyranoside] (**182**)



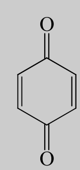
Prunetin 4'-*O*-galactoside (**183**)



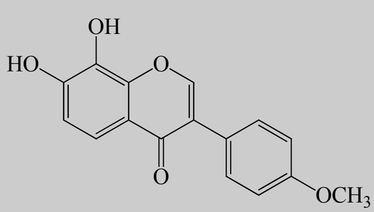
Prunetin 4'-*O*-glucoside (**184**)



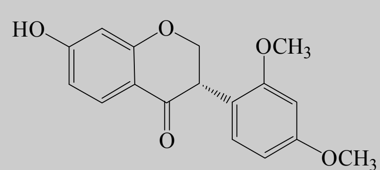
Pseudobaptigenin (**185**)



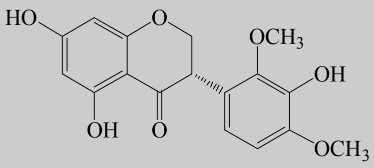
Quinone (**186**)



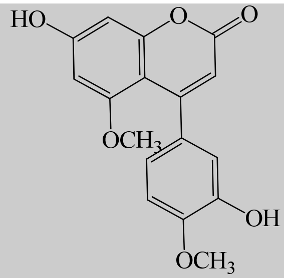
Retusin (**187**)



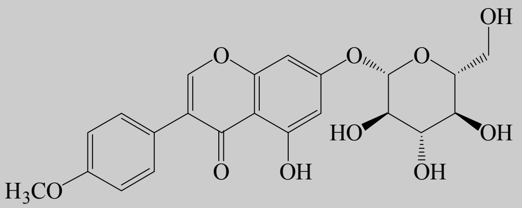
(3*S*)-Sativanone (**188**)



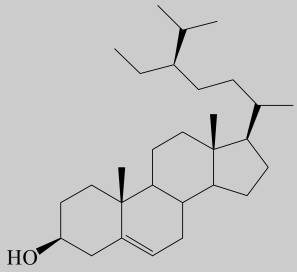
(3*S*)-Secundiflorol H (**189**)



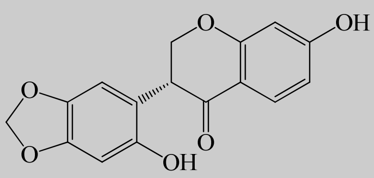
Seshadrin (**190**)



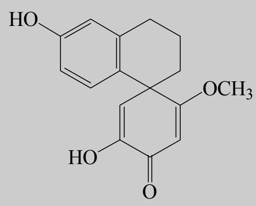
Sissotrin (**191**)



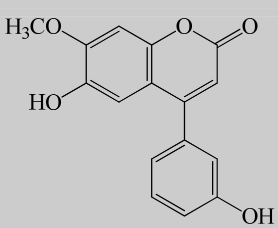
Sitosterol (**192**)



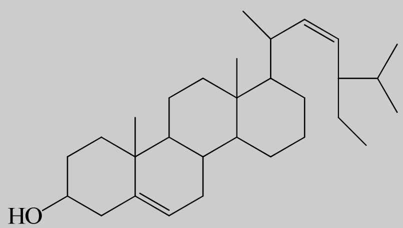
Sophorol (**193**)



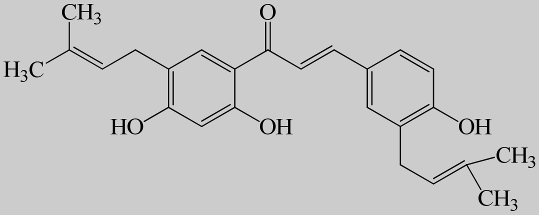
Spirolouveline (**194**)



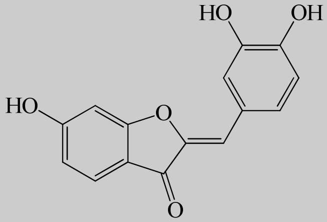
Stevenin (**195**)



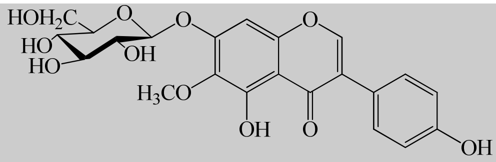
Stigmasterol (**196**)



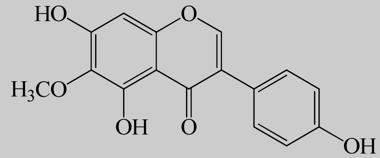
Stipulin (**197**)



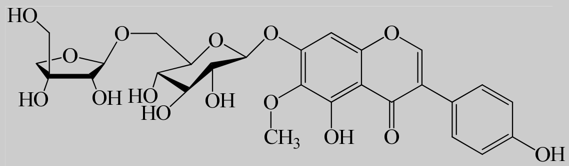
Sulfuretin (**198**)



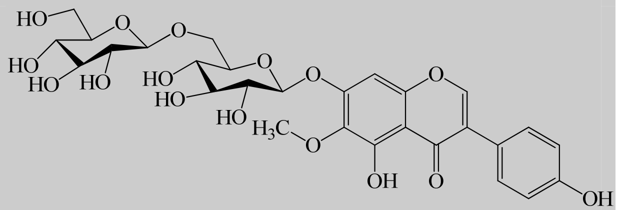
Tectoridin (**199**)



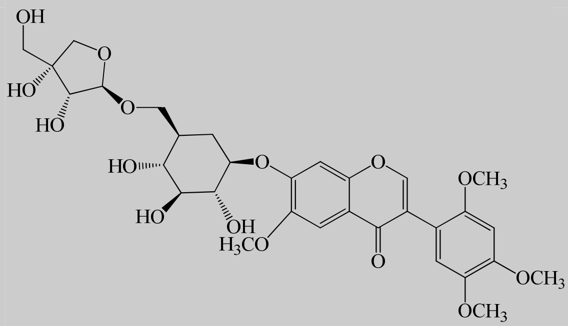
Tectorigenin (**200**)



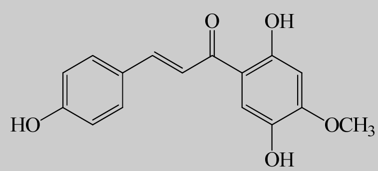
Tectorigenin 7-*O*-[β-D-apiofuranosyl-(1→6)-β-D-glucopyranoside] (**201**)



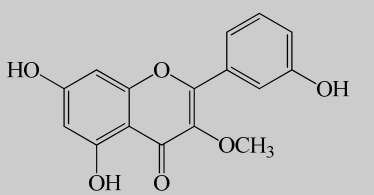
Tectorigenin 7-*O*-gentiobioside (**202**)



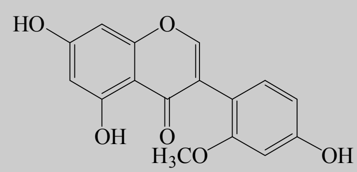
2′,4′,5′,6-Tetramethoxy-7-[(6-*O*-β-D-apiofuranosyl-β-D-glucopyranosyl)oxy]-isoflavone (**203**)



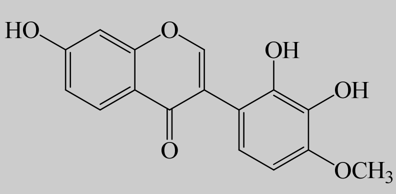
4,2′,5′-Trihydroxy-4′-methoxychalcone (**204**)



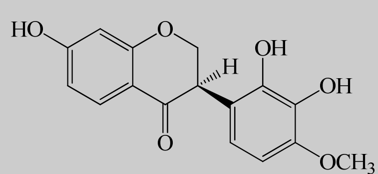
4′,5,7-Trihydroxy-3-methoxyflavone (**205**)



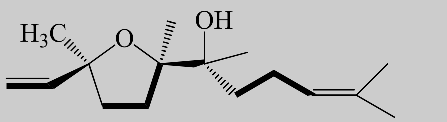
4′,5′,7-Trihydroxy-2′-methoxyisoflavone (**206**)



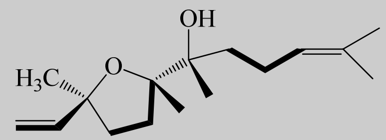
2′,3′,7-Trihydroxy-4′-methoxyisoflavanone (**207**)



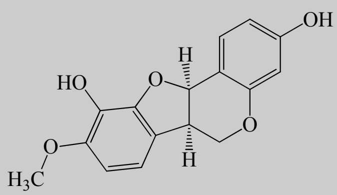
(3*R*)-2',3',7-Trihydroxy-4'-methoxyisoflavanone (**208**)



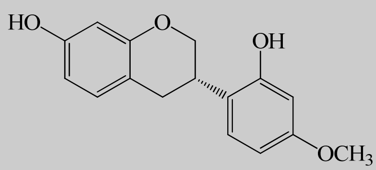
(3*S*,6*R*,7*R*)-3,7,11-Trimethyl-3,6-epoxy-1,10-dodecadien-7-ol (**219**)



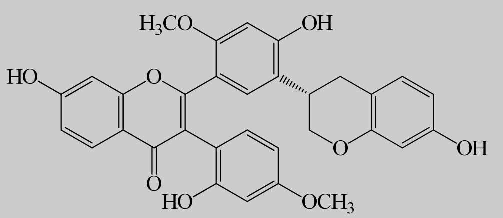
(3*S*,6*S*,7*R*)-3,7,11-Trimethyl-3,6-epoxy-1,10-dodecadien-7-ol (**210**)



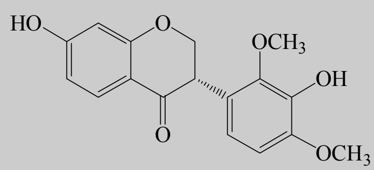
(6a*R*, 11a*R*)-Vesticarpan (**211**)



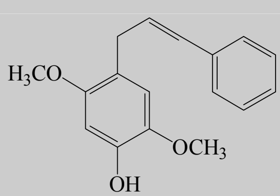
Vestitol (**212**)



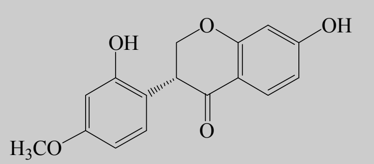
Vestitol-(5'→2)-2'-hydroxyformononetin (**213**)



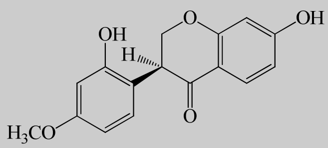
Violanone (**214**)



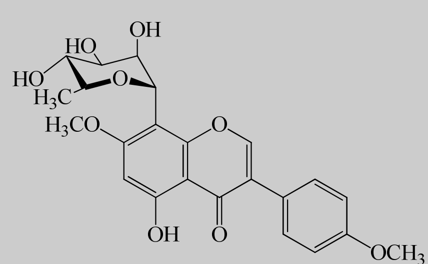
Violastyrene (**215**)



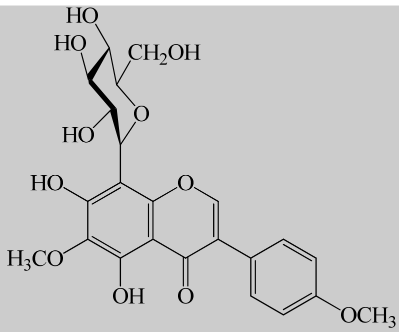
Vestitone (**216**)



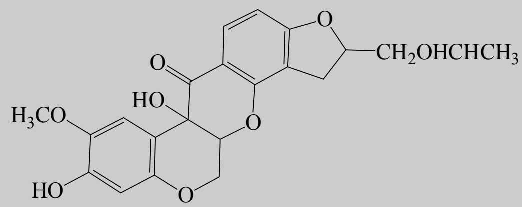
(3*R*)-Vestitone (**217**)



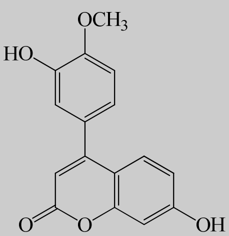
Volubilin (**218**)



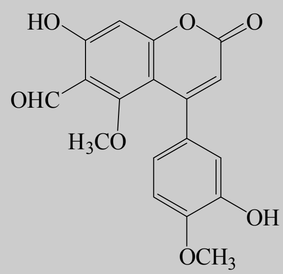
Volubilinin (**219**)



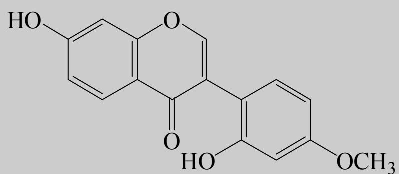
Volubinol (**220**)



Volubolin (**221**)



Voludal (**222**)



Xenognosin B (**223**)

nitrogen containing secondary metabolites, quinolizidine ring containing are most common (Wink and Mohamed, 2003). Interestingly no alkaloids were reported so far from *Dalbergia* genus although some of the works were carried out with the roots, where the presence of nitrogen containing secondary metabolites is most likely to occur.

Very few terpenes have been reported so far from the genus *Dalbergia*. Only two sesquiterpenes were reported so far and were isolated from the essential oil of *D. odorifera* (Tao et al., 2010). Friedelin, isolated from *D. erruginea* is the only triterpene reported from the genus *Dalbergia* (Donnelly et al. 1972). A triterpene glycoside containing fructose, named dalsaxin was isolated from *D. saxatilis* however the structure of the compound was not given may be due to insufficient data (Uchendu and Leek, 1999b) The common phytosterols, namely stigmasterol and sitosterol were isolated from *D. monetaria* and *D. erruginea*, respectively (Khan et al., 1997; Donnelly et al. 1972). The other sterol, campsterol was also reported from *D. monetaria* (Khan et al., 1997).

Some of the timber producing *Dalbergia* species are famous for their fragrant wood and are termed as rosewood. Although some other genera of legume family also produce fragrant woods, the most desired rosewoods are *D. nigra* and *D. latifolia*. Most of the phytochemical works found on *Dalbergia* species are on the heartwood. The presence of aromatic oils might have prompted the researchers to work on the heartwood.

Most of *Dalbergia* species contain sensitizing quinones in their heartwood which are known for their skin irritation. Different derivatives of dalbergione are present depending on species. In one study, among several quinones, *R*-3,4-dimethoxydalbergione was found to be the most irritant (Mitchell and Rook, 1979). However, it might not be as strong as some other naturally occuring skin irritants (Schulz et al, 1979). In another study, contact dermatitis was reported due to an arm bracelet made of Brazilian rosewood (*D. nigra*). Three quinones, namely, *R*-4-methoxydalbergione, *S*-4,4'-dimethoxydalbergione, and *S*-4'-hydroxy-4-methoxydalbergione were identified as the responsible agents (Hausen, 1982).

Pharmacological studies

A number of species of the *Dalbergia* genus are widely used in traditional medicine systems. However, relatively few of these have been investigated from an evidence-based pharmacological approach. As a result, only a small number of bioactive compounds have been isolated and reported. The pharmacological activities of different species and the activities of their isolated bioactive compounds are described below:

Analgesic activity

The analgesic activity of the ethanol extract of the bark of *D. sissoo* was investigated using the tail flick method in Wistar rats. The extract at the doses of 300, 500 and 1000 mg/kg was reported to possess significant and dose dependent, central analgesic activity, compared with the standard drug aspirin at the dose of 300 mg/kg (Asif et al., 2011). An ethanol extract of the leaves of *D. sissoo* showed both peripheral and central analgesic activity in a dose dependent manner. Peripheral analgesic activity was studied using the acetic acid-induced writhing reflex and Randall-Selitto assays in mice as well as central analgesic activity was studied using the hot-plate and tail-clip tests in mice (Hajare et al., 2000). In writhing test, the extract (100, 300 and 1000 mg/kg) moderately inhibited writhing in mice while aspirin (300 mg/kg) showed strong activity; in Randall-Selitto assay, the extract failed to increase pain threshold level at the doses of 100 and 300 mg/kg but exhibited significant ($P<0.01$) activity at the dose of 1000 mg/kg and comapared with the aspirin (300 mg/kg) which increased pain threshold throughout the observation period of 1 to 3 h; in hot-plate test, the extract (1000 mg/kg) increased reaction time at 2 and 3 h while pathidine (5 mg/kg) increased reaction time at 1 and 2 h; in tail-clip test, the extract failed to increase reaction time even at the higher dose of 1000 mg/kg (Hajare et al., 2000). An ethanol extract of the bark of *D. lanceolaria* also showed both peripheral and central analgesic activity in acetic acid-induced writhing, tail-flick, and formalin-induced licking tests in Swiss-Albino mice in significant and dose dependent manner at the doses of 100, 200 and 400 mg/kg (Misar et al., 2005). The crude methanol extract of the stem bark of *D. spinosa* showed potential analgesic activity in the acetic acid-induced writhing model with an inhibition of 40.01% at a dose of 500 mg/kg body weight as compared with the control (Raihan et al., 2012). The methanol extract of the spike of *D. spinosa* showed significant analgesic activity in the acetic acid-induced writhing test in mice with inhibition of 33.34 and 63.89% at the doses of 250 and 500 mg/kg while standard drug diclofenac sodium showed 75% inhibition of writhing at the dose of 25 mg/kg (Bala et al., 2011).

Angiogenesis activity

In chick embryo chorioallantoic membrane (CAM) model, the frize dried aquous root heartwood extract of *D. odorifera*, increased the vessels on CAM by 95.24±11.28 and 169.05 ± 30.28% at the concentrations of 0.2 and 1 g herb/mL, respectively, while basic fibroblast growth factor (bFGF) increased 156.19±28.55 and 211.43±35.65% at the same concentrate-ions, respectively (Wang et al., 2004). In bovine aortic endothelial cells (BAEC) culture model, the frize dried aquous core of root extract of *D. odorifera*, increased the living cell numbers by 37.05±3.39 and 50.35±7.11% at the concentrations of 0.2 and 1 g herb/mL, respectively, while bFGF increased 161.39±41.68 and 216.92±19.57% at the same concentrations, respectively (Wang et al., 2004).

Anthelmintic activity

The petroleum ether, carbon tetrachloride, benzene and ethanol extracts of leaves of *D. sissoo* were assessed for anthelmintic activity against Indian earthworms (*Pheretima posthuma*) at different concentrations of 10, 25, 50, and 100 mg/mL, and compared wth piperazine citrate (Hood et al., 2012). All the extracts revealed anthelmintic activity against the eartworms and the carbon tetrachloride extract exhibited most ptent activity with the paralysis time of 19.14±2.78 min and death time of 48.15±3.23 min at the concentration of 100 mg/mL, while piperazine citrate showed 5.23±0.72 and 20.45±2.33 min, respectively at the concentration of 10 mg/mL (Hood et al., 2012).

Anti-allergic activity

The flavonoids (*S*)-4-methoxydalbergione (**146**) and cearoin (**31**), isolated from the heartwood of *D. odorifera*, showed significant anti-allergic activity in defferent models (Chan et al., 1998). (*S*)-4-methoxydalbergione (**147**) and cearoin (**31**) showed IC_{50} values of 17.6 and 17.9 μM, respectively against the release of β-glucuronidase and IC_{50} values of 20.0 and 16.3 μM, respectively against the release of histamine from mast cells, and mepacrine was used as positive control (Chan et al., 1998). (*S*)-4-methoxydalbergione (**147**) and cearoin (**31**) also showed IC_{50} values of 20.6 and 7.9 μM, respectively against the release of *β*-glucuronidase and IC_{50} values of >30.0 and 11.7 μM, respectively against the release of lysozyme from rat neutrophils, and trifiuoperazmne was used as positive control (Chan et al., 1998).

Anti-androgen activity

A methanol extract of heartwood of *Dalbergia cochinchinensis* Pierre, showed potent anti-androgen activity by inhibiting testosterone 5α-reductase and formation of 5α-dehydrotestosterone (DHT)-receptor complex (Kuroyanagi et al., 1996). Bioacative constituents, latifolin (**129**), methoxydalbergione (**145**), 5-*O*-methoxylatifolin (**148**), 2,5-dihydroxy-4-methoxybenzophenone (**78**), isoliquiritigenin (**116**), liquiritigenin (**134**), calycosin (**12**), and darbergiol (**66**), isolated from the methanol extract of heartwood of *D. cochinchinensis*, showed potent anti-androgen activity (Kuroyanagi et al., 1996). Methoxydalbergione (**145**) showed most potent activity with the inhibitory effect of 69.9% on testosterone 5*α*-reductase, and 85.3% on 5*α*-(DHT)-receptor complex formation at the concentration of 100 μg/mL (Kuroyanagi et al., 1996).

Anti-arthritic activity

The etherial, petroleum ether, aqueous, and alcohol extracts of *D. lanceolaria* showed significant and potent anti-arthritic activity against formaldehyde-induced arthritis in young albino rats as compared with the standard anti-arthritic drug cortisone acetate (Singh et al., 1966). The mean joint swelling was reduced by all the extracts as well as by cortisone. The mean joint swelling values on the 11th day were of 1.04±0.56, 1.40±0.06, 1.79±0.61, 1.19 ± 0.81 and 0.53±0.74 mm for etherial, alcoholic, petroleum ether, watery extracts and cortisone acetate, respectively meanwhile the control group showed 2.10±0.48 mm (Singh et al., 1966).

Anticancer activity

The methanol extract of the heartwood of *D. odorifera* T.C.Chen possessed significant and potent inhibition of the proliferation of human tumor cell lines, including multidrug resistant cells *in vitro*. Seven flavonoids medicarpin (**137**), 2-hydroxy-3,4-dimethoxybenzaldehyde (**103**), formononetin (**92**), tectorigenin (**200**), mucronulatol (**157**), (3*R*)-5′-methoxyvesitol (**150**), hydroxyobtustyrene (**108**), and two phenolic components liquiritigenin (**134**) and (3*R*)-calussequinone (**11**), isolated from the heartwood exhibited as active consitituents for cytotoxic activity of methanol extract of heartwood (Choi et al., 2009). Medicarpin (**137**) and hydroxyobtustyrene (**108**) exhibited most potent cytotoxic activity with IC_{50} value of 5.71-7.28 and 5.14-6.83 μg/mL, respectively against all the tested cell lines and other comounds showed moderate cytotoxic property meanwhile doxorubicin exhibited IC_{50} values of 0.0010- 0.0887 μg/mL (Choi et al., 2009). A cytotoxic compound, 2'-*O*-methyl-isoliquiritigenin, isolated from the heartwood of *D. odorifera*, showed cytotoxic activity against A-549, SK-MEL-2, and SK-OV-3 cancer cell lines, and the activity was higly coparable with the 5-fluorouracil (Park et al., 1995). Several isoflavones isolated from the heartwood of *D. parviflora* Roxb. showed effects on estrogenic-responsive human breast cancer cells. Isolated compounds were evaluated for their cell proliferation stimulatory activity against the MCF-7 and T47D human breast cancer cell lines. Their luciferase inductive effects were investigated using luciferase transiently transfected MCF-7/luc and T47D/luc cell lines (Umehara et al., 2009). Genistein (**95**), biochanin A (**2**), tectorigenin (**200**), and 2′-methoxyformononetin (**147**), stimulated the proliferation of both cells at the concentration of lower than 1 μM and activity was equivalent to the activity of 10 pM of estradiol (Umehara et al., 2009). An isoflavone (3*S*)-Secundiflorol H (**189**), isolated from the stems of *D. parviflora*, showed strong cytotoxic activity against KB, MCF-7, and NCI-H187 cell lines with IC_{50} values ranging from 3.5 to 5.4 μg/mL (Songsiang et al., 2011). The methanol extract of the spikes of *D. spinosa* showed toxicity in the brine shrimp lethality bioassay with an LC_{50} value of 15 μg/mL (Bala et al., 2011). 6,2'-Dimethoxy-7,4'-dihydroxyisoflavone (**85**), isolated from *D. vaccineiifolia* Vatke, was reported, with an LC_{50} value of 266 μg/mL against brine shrimp larvae (Innocent et al., 2010). An isoflavone mucronulatol (**157**), isolated from *D. oliveri* Gamble ex Prain showed significant cytotoxic activity against the HBL100 leukemia cell line with an LC_{50} value amounting to 5.7 μM (Deesamer et al., 2007). An ethanol extract of leaves of *D.*

spinosa, was cytotoxic, against brine shrimp nauplli with the LC_{50} value of 84.14 µg/mL, while vincristine sulphate showed 0.64 µg/mL (Saha et al., 2013).

Antidiabetic activity

Hypoglycemic and antihyperglycemic effects of the ethanol extract of leaves of *D. sissoo* were investigated in normal and alloxan induced rats at the doses of 250 and 500 mg/kg, and compared with glibenclamide (Niranjan et al., 2010). The extract reduced the blood glucose level up to 189.2, 115.2, and 104.6 mg/dL at successive days of 7, 14, and 21, at the dose of 500 mg/kg, while glibenclamide reduced upto 250.2, 141.2, and 120.4 mg/dL (Niranjan et al., 2010). In comparison to glibenclamide, the extract was 12% more effective in reducing blood glucose level (Niranjan et al., 2010).

Anti-diarrheal activity

The effect of a decoction of the dried leaves of *D. sissoo* in infectious diarrhea, and the probable mechanism of action, was investigated in a cholera and labile toxin assay. The decoction of the dried leaves inhibited the production of cholera toxin (CT), and at the same time it also increased the production of labile toxin (LT). The binding of both LT and CT to the GM1 (monosialotetrahexosylganglioside) receptor was reduced (Brijesh et al., 2006). The ether, ethanol and aqueous extracts of bark of *D. sissoo* were investigated for anti-diarrheal activity in castor oil induced diarrhea in rats at the doses of 200 and 400 mg/kg, and compared with loperamide (1 mg/kg) (Kalaskar et al., 2012). The ether extract was most potent with the inhibition of 84.61% at the dose of 400 mg/kg, while loperamide showed inhibition of 65.71% at the dose of 1 mg/kg (Kalaskar et al., 2012). All the extracts at the dose of 400 mg/kg also reduced the intestinal transit time in charcoal meal and compared with atropine sulphate (1 mg/kg i.p.) (Kalaskar et al., 2012). An ethanol extract of the bark of *D. lanceolaria* showed moderate anti-diarrheal activity in castor oil induced diarrhea in mice at the dose of 400 mg/kg at 4 h and in magnesium sulfate-induced diarrhea in mice, activity was strong enough at lower dose of 100 mg//kg at 6 h but in both model activity was less as compared to diphenoxylate HCl (Mujumdar et al., 2005). The extract also reduced intraluminal fluid accumulation in a castor oil-induced, intraluminal fluid accumulation assay, and decreased the intestinal motility in charcoal and barium chloride treated animals (doses of extract were 100, 200 and 400 mg/kg and compared to loperamide at the dose of 5 mg/kg) (Mujumdar et al., 2005).

Antifertility activity

The antifertility activity of a triterpenoid glycoside isolated from the roots of *D. saxatilis* Hook.f. was investigated in female Wistar rats. Inhibition of conception occurred in 71.4% of the treated animals at the dose of 200 mg/kg body weight at the premating period by gastric intubation. The fertility Index (FI) was 107.82 as compared with 373.5 for the untreated control group and it was calculated using the formula of FI = (LFN × FCRL × PPF)/CLN, where LFN indicates mean live foetal number per pregnant female; FCRL indicates mean Day 20 foetal crown-rump length (cm); PPF indicates percentage of pregnant female animals in each group and CLN indicates mean corpus luteum number per pregnant female (Uchendu et al., 2000).

Antigiarrdial activity

The extracts, and the bioactive compound, formononetin (**92**), isolated from the bark of *D. frutescans* (Vell.) Britton were reported to possess significant and potential antigiarrdial activity against *Giardia intestinalis*, with IC_{50} value of 30 ng/ml (approx. 0.1 μM) as compared to the standard drug metronidazole which showed an IC_{50} value of 100 ng/ml (approx. 0.6 μM) (Khan et al., 2000).

Anti-inflammatory activity

The anti-inflammatory activity of the methanol extract of the roots of *D. sissoo* was investigated in a carrageenan-induced paw edema assay in rats. The extract was reported with significant and potential anti-inflammatory activity, without any side effect, on gastric mucosa observed in acute and chronic ulcerogenic tests conducted in rats at the doses of 100, 500, and 1000 mg/kg, and the most potent activity was at the dose of 1000 mg/kg throughout the observation period of 4 h, and compared with indomethacin (10 mg/kg) (Kumar et al., 2010). The potential anti-inflammatory activity of an ethanol extract of the leaves of *D. sissoo* was also investigated (Hajare et al., 2001). The extract significantly inhibited carrageenin induced paw edema with 29.55, 34.09 and 43.18% inhibition at the doses of 100, 300 and 1000 mg/kg, respectively as compared to phenylbutazone (100 mg/kg) showed 50% inhibition of edema; in Kaolin-carrageenin induced paw edema, the extract (300 and 1000 mg/kg) showed significant activity after 6 h and persisted for 24 h as compared to acetylsalicylic acid (300 mg/kg); in nystatin-induced paw edema, the activity was strong at only the highest dose of 1000 mg/kg as compared to phenylbutazone (100 mg/kg) and also reduced the weight of granuloma induced by a cotton pellet at the all dose levels. Inhibition of dye leakage in the acetic acid-induced vascular permeability test conducted in mice was also observed at the doses of 300 and 1000 mg/kg as compared to acetylsalicylic acid (300 mg/kg) in significant and dose dependent manner (Hajare et al., 2001). An ethanol extract of the bark of *D. sissoo* also showed anti-inflammatory activity in right hind paw edema method in Wistar rats at the doses of 300, 500 and 1000 mg/kg as compared with the standard drug indomethacin (10 mg/kg) and the extract showed most potent activity at the dose of 1000 mg/kg (Asif et al., 2009). Biochanin-A (5,7-dihydroxy-4-methoxyisoflavone) (**2**), isolated from the flowers of *D. sissoides* Graham showed antiinflammatory activity in carrageenin induced rat hind paw edema with 35.85% inhibition of edema as compared to ketorolac tromethamine (54.92%) (Kavimani et al., 1997). This compound also showed dose dependent, anti-inflammatory activity in the prostaglandin E (PGE), bradykinin, 5-hydroxytryptamine (5-HT), and histamine-induced rat hind paw edema assay (Kavimani et al., 2002).

The topical and systemic anti-inflammatory activities of the ethanol extract of the bark of *D. lanceolaria* were investigated in different animal models. Topical anti-inflammatory activity was tested in the 12-*O*-tetradecanoylphorbol-3-acetate (TPA), ethyl phenyl propiolate (EPP), and arachidonic acid (AA)-induced ear edema assays in mice. In TPA, the extract showed 79.89% inhibition of inflammation at the dose of 1 mg/ear as compared to indomethacin (0.5 mg/ear) showed 67.83% inhibition; in EPP, inhibition was 40.02 and 59.58% at the doses of 0.5 and 1 mg/ear, respectively as compared to dexamethasone (0.5 mg/ear) showed 69.08% inhibition; in AA, inhibition was 66.49 and 72.22 at same doses respectively as compared to phenidone (1 mg/ear) showed 83.72% inhibition (Kale et al., 2007). Systemic anti-inflammatory activity has been tested in acute and sub-acute anti-inflammatory models in albino rats. In Histamine, 5-HT and PGE1 induced rat paw edema, the bark extract showed inhibition of edema at the dose of 100 mg/kg (Kale et al., 2007). The ethanol bark extract was also reported to show significant systemic anti-inflammatory activity in the carrageenan-induced rat paw edema assay at the doses of 100, 200 and 400 mg/kg as compared to indomethacin (10 mg/kg) up to the observation period of 4 h, and also exhibited activity against turpentine oil-induced exudative changes at the doses of 50 and 100 mg/kg as compared to indomethacin (1 mg/kg) as well as leukocyte count was reduced at both doses for 7 days (Kale et al., 2007). The flavonoids (*S*)-4-methoxydalbergione (**146**), cearoin (**31**), butein (**8**), koparin (**127**), bowdichione (**7**), 3'-*O*-methylviolanone (**156**), and xenognosin B (**223**), isolated from the heartwood of *D. odorifera*, showed significant anti-inflammatory activity by inhibiting superoxide anion formation from rat neutrophils induced by Formyl-Met-Leu-Phe (FMLP) and phorbol 12-myristate 13-acetate (PMA), and results were compared with trifluoperazine (Chan et al., 1998). The compounds showed IC_{50} values ranging from 3.0 to >100 and 0.9 to >100 µM against the formation of superoxide anion induced by FMLP and PMA, respectively (Chan et al., 1998). The methanol extract of the leaves of *D. paniculata* showed anti-inflammatory activity in the carrageenan-induced inflammation model in rats with a maximum inhibition of 47.83% at 3 h at the dose of 800 mg/kg and compared with indomethacin (5 mg/kg) (Ganga et al., 2012).

Antimicrobial activity

A biherbal preparation, comprised of bark of *D. sissoo* and seeds of *Datura stramonium* L. (Solanaceae) with cow urine was reported to have antimicrobial activity against some Gram-positive (*Staphylococcus aureus* and *Streptococcus pneumoniae*) and Gram-negative (*Escherichia coli*, *Pseudomonas aeruginosa*, and *Klebsiella pneumoniae*) bacterial strains as compared with the standard drugs, chloramphenicol (30 mcg), Nalidixic acid (10 mcg), Ampicillin (10 mcg) and Rifampicin (30 mcg) (Yadav et al., 2008). The biherbal preparation showed the zone of inhibition of 25.38±0.21, 24.85±0.41, 8.56±0.36, 13.56±0.89, and 9.33 ± 0.32 mm against *S. aureus*, *S. pneumoniae*, *E. coli*, *K. pneumoniae*, *P.aeruginosa*, respectively in disk diffusion assay (Yadav et al., 2008). Antibacterial and antifungal activities of the methanol, citric acid, aqueous, dichloromethane, and petroleum ether bark extracts of *Dalbergia melanoxylon* Guill. & Perr. were investigated using the agar well method. The citric acid extract was reported with strongest antimicrobial activity against both bacterial (*Bacillus subtilis, E. coli*, *K. pneumonia, P. aeruginosa*, *Salmonella typhimurium*, *Staphylococcus aureus* and *Yersinia pestis*) and fungal (*Aspergillus niger* and *Candida albicans*) strains (Gundidza et al., 1993). The citric acid extract showed MIC values of 2.81, 6.25, 11.83, 6.25, 50, 3.35, and 50 µg/mL, and MBC values of 5.12, 12.5, 24, 12.5, 65, 12.6, and 65 µg/mL, against the bacterial strains of *B. subtilis*, *E. coli*, *K. pneumonia, P. aeruginosa, S. typhimurium*, *S. aureus*, and *Y. pestis,* respectively, and activity was highly comparable with tetracycline hydrochloride (MICs: 3.31, 12.5, 13.3, 100, 12.5, 103, and 12.5 µg/mL, and MBCs: 13.1, 25, 51.1, 135, 50, 139, and 100 µg/mL, respectively) (Gundidza et al., 1993). In antifungal test, the citric acid and dichloromethane extracts (0.625 mg/mL) showed 59.1 and 62.8% inhibition against *C. albicans,* and 55.7, and 61.0% inhibition against *A. niger*, respectively (Gundidza et al., 1993). Inhibition was expressed as percentage relative to the control flasks, and activity was highly comparable with nystatin (70.30 and 75.40% inhibition against *C. albicans,* and *A. niger*, respectively) (Gundidza et al., 1993). The ethanol extracts of the leaves and bark of *D. saxatilis* Hook.f. were investigated for their antimicrobial activity against six pathogenic microorganisms. The leaf extract was reported with antibacterial activity against only *S. aureus* with minimum inhibition concentration (MIC) of 1000 mg/mL, and the bark extract was reported with broad spectrum activity at MIC values of 250, 125, 1000, and 1000 mg/mL against bacterial strains of *S. aureus*, *B. subtilis*, *E. coli*, and *P. aeruginosa*, respectively (Okwute et al., 2009). The flavonoids sativanone (**188**), (3*R*)-vestitone (**217**), (3*R*)-2',3',7-trihydroxy-4'-methoxyisoflavanone (**208**), (3*R*)-4'-methoxy-2',3,7-trihydroxyisoflavanone (**149**), carthamidin (**26**), liquiritigenin (**134**), isoliquiritigenin (**116**), (3*R*)-vestitol (**212**), and sulfuretin (**198**), isolated from the heartwood of *D. odorifera*, were reported to show antibacterial activity against the Gram-negative pathogen *Ralstonia solanacearum* in disk diffusion method (Zhao et al., 2011). Sativanone (**188**), (3*R*)-vestitone (**217**), (3*R*)-2',3',7-trihydroxy-4'-methoxyisoflavanone (**208**), (3*R*)-4'-methoxy-2',3,7-trihydroxyisoflavanone (**149**), carthamidin (**26**), liquiritigenin (**134**), isoliquiritigenin (**116**), (3*R*)-vestitol (**212**), and sulfuretin (**199**), exhibited the zone of inhibition of 6.53±0.05, 11.19±0.15, 8.11±0.14, 9.99 ± 1.25, 8.34±0.16, 12.23±0.45, 14.15±0.95, 16.62±1.07 and 9.10±1.22 mm, respectively against *R. solanacearum* and compared with streptomycin sulfate (16.80±0.33 mm) (Zhao et al., 2011). The benzene, alcohol, and aqueous root extracts of *D. spinosa* were investigated for their antimicrobial activity against selected Gram-positive (*S. aureus*) and Gram-negative (*P. aeruginosa*, *K. pneumoniae*, *E. coli*) bacterial strains, as well as fungal (*C. albicans*) strain in cup plate method. Benzene and alcohol extract at the concentrations of 50 75 and 100 µg/mL and aqueous extract only at 100 µg/mL exhibited potential antimicrobial activity (Senthamarai et al., 2003). Various extracts (hexane, diethyl ether, ethyl acetate and acetone) of the heartwood of *D. congestiflora* Pittier were investigated for their antifungal activity against *Trametes versicolor*. The hexane extract showed 100% inhibition of fungal growth at the concentrations of 250 and 500 mg/L. An antifungal compound, (+)-medicarpin (**138**) was isolated from this extract and showed same level of activity at the concentration of 150 mg/L (Martínez-Sotres et al., 2012). Mucronulatol (**157**) and violanone (**214**), isolated from *D. oliveri* showed antifungal activity against *Fusarium oxysporum* in direct bioautographic assay (mucronulatol at 0.5 µg and violanone at 1 µg amount spotted on TLC plate showed clear zone of inhibition and compared with iprodion and captan at amount of 0.1 µg) (Deesamer et al., 2007). An ethanol extract of leaves of *D. spinosa*, showed antibacterial activity in disc diffusion assay with the diameter of zone of inhibition of 7, 8, 11, 9, 14, 9, 10, 9, and 8 mm against the bacterial strains of *S. aureus*, *Staphylococcus epidermidis*, *Streptococcus pyogenes*, *Salmonella typhi*, *P. aeruginosa*, *Shigella flexneri*, *Shigella sonnei*, *Shigella dysentery*, and *Shigella boydii*, respectively at 500 µg/disc, and the activity was compared with kanamycin (30 µg/disc) (Saha et al., 2013). The MIC values of the extract were determined in broth macrodilution assay, and compared with ceftriaxone. The values were ranged between 250 and 500 µg/mL against all the tested bacterial strains (Saha et al., 2013).

Antioxidant activity

The ethanol extract of the bark of *D. sissoo* was screened for antioxidant potential (Kumari et al., 2008). The total phenolic was 58.06 gallic acid equivalents (GAE) mg/g of extract and tannin content was varied from 218.34 to 61.75 mg catechin equivalent (CE)/g of extract. Lipid peroxidation inhibitory (LPO) and NO quenching potentials were investigated and reported. The bark extract showed 69.1% LPO inhibitory potential/10 µg of extract, and trolox was used as positive control (Kumari et al., 2008). Superoxide dismutase (SOD) mimetic activity was 116.62 unit/min/mg extract and catechin was used as positive control as well as total antioxidant capacity (TAC) and ABTS radical cation decolorisation power were also investigated for bark extract (Kumari et al., 2008). The antioxidant potential of the aqueous and methanol extracts of the stem bark of *D. sissoo* was measured using the 1,1-diphenyl-2-picrylhydrazyl (DPPH) radical scavenging assay, the ferric ion reducing power assay, the ferrous ion chelating assay, and the measurement of Au nanoparticle formation. In DPPH assay, the IC_{50} value of the aqueous extract was 12.23±1.11 µg/mL while the methanol extract showed IC_{50} value of 23.63±1.65 µg/mL and gallic acid was used as standard; concentration dependent activity was observed in both reducing power (gallic acid as standard) and ferrous ion chelating (EDTA as standard) assay and sharp surface plasmon resonance (SPR) band was appeared at 539 and 543 nm for aqueous and methanol extract, respectively and compared with natural extract of amla (Roy et al., 2011). Total polyphenol content of the aqueous and methanol extract was 153.35 ± 4.42 mg GAE/g and 189.79 ± 4.27 mg GAE/g, respectively and flavonoid content was 45.33 ± 0.14 mg quercetin QE/g and 49.41 ± 0.49 mg QE/g (Roy et al., 2011). The methanol extract of the leaves of *D. saxatilis* was investigated for DPPH radical scavenging activity, total antioxidant capacity, reducing power, and the total phenolic compound content present (Sofidiya et al., 2006). In DPPH assay, the extract showed 71.1 ± 0.019 % inhibition at the concentration of 0.20 mg/mL as compared to α-tocopherol (97.9 ± 0.001% at 0.20 mg/mL); in reducing power assay absorbance was 0.846 ± 0.056 at 0.40 mg/mL as compared to α-tocopherol (1.589 ± 0.089 at 0.40 mg/mL) and total phenolic content was 4.47 ± 0.001 mg GAE/g of extract (Sofidiya et al., 2006). Butein (**8**) iso-lated from *D. odorifera* showed DPPH radical scavenging activity with an $IC_{0.200}$ value of 9.2 ± 1.8 µM as compared to α-tocopherol (11.9 ± 0.2 µM) and BHT (14.5 ± 2.5 µM), and exhibited inhibition of xanthine oxidase with an IC_{50} value of 5.9 ± 0.3 µM (Cheng et al., 1998). It scavenged the peroxyl radical derived from 2,2-azobis(2-amidinopropane) dihydrochloride (AAPH) in the aqueous phase, and also inhibited copper-catalyzed oxidation of human low-density lipoprotein (LDL) in a concentration dependent manner with an IC_{50} value of 6.3 ± 0.2 µM. (Cheng et al., 1998). Butein (**8**) also inhibited iron-induced lipid peroxidation in rat brain homogenate with IC_{50} value of 3.3 ± 0.4 µM and compared with BHT (IC_{50} value of 1.3 ± 0.1 µM), in iron and copper chelation study, the Fe^{2+}-butein complex showed peaks at 286 and 422 nm while the Cu^{2+}-butein complex showed peaks at 286 and 454 nm, and it was more effective than ascorbic acid in the prevention of AAPH-induced cis-parinaric acid oxidation in LDL (Cheng et al., 1998). A new benzophenone 2,4-dihydroxy-5-methoxybenzophenone (**78**) and eight known compounds namely 2´,3´,7-trihydroxy-4´-methoxyisoflavanone (**207**), 3´-methoxydaidzein (**144**), 4´,5,7-trihydroxy-3-methoxyflavone (**205**), vestitol (**212**), medicarpin (**137**), hexadecanoic acid, ethyl ester (**100**), hexanoic acid, 2-propenylester (**101**) and 3,8-nonadien-2-one (**164**) were isolated from the root of *D. odorifera* and investigated for antioxidant potentials using an oxidative stability instrument at 100˚ C in American Oil Chemists' Society Official Oil Stability Index (OSI) method (Wang et al., 2000). Among nine compounds first six compounds showed significant activity as compared to BHT and α-tocopherol in OSI (Wang et al., 2000). Naringenin (**158**) and eriodictoyl (**92**), isolated from the heartwood of *D. odorifera*, showed stronger antioxidant activity than the synthetic antioxidant BHT in OSI, reducing power and ABTS methods (Hou et al., 2011). In OSI method, antioxidant activity was expressed as Protection factor (Pf) calculated using the formula of $Pf = IP_{antioxidant} / IP_{lard}$ where, $IP_{antioxidant}$ and IP_{lard} were the oxidation induction potential (IP) with and without antioxidant, respectively (Hou et al., 2011). Naringenin (**158**) and eriodictoyl (**91**) showed Pf value of 4.20 ± 0.02 and 6.48 ± 0.31, respectively at concentrations of 0.012% and when concentration was increased to 0.02% the Pf values were 5.57 ± 0.07 and 9.32 ± 0.28, respectively and compared to BHT (3.61 ± 0.10 and 4.22 ± 0.48 for 0.012 and 0.02%, respectively) (Hou et al., 2011). In reducing power and ABTS radical scavenging assay, both compounds showed stronger activity than BHT in concentration dependent manner (Hou et al., 2011). Ethanol seed extract of *D. odorifera* was partitioned using petroleum ether, ethyl acetate, n-butanol and water, and each part was investigated for total phenolic and flavonoid content, DPPH radical scavenhing activity, reducing power, linoleic acid and lard peroxidation inhibition activity (Lianhe et al., 2011). Total phenolic content of 135.5 ± 13.4, 563.2 ± 11.3, 167.3 ± 10.6 and 135.0 ± 4.2 mg GAE/g extract and flavonoid content of 103.7 ± 1.6, 350.3 ± 3.1, 79.9 ± 0.6, 115.1 ± 1.6 mg rutin equivalent (RU)/g extract were found for petroleum ether (PE), ethyl acetate (EE), n-butanol (BE) and water (WE) extracts, respectively (Lianhe et al., 2011). In DPPH assay, PE, EE, BE and WE showed scavenging activity of 67.1 ± 0.2, 62.8 ± 0.5, 57.2 ± 1.1 and 59.5 ± 1.0%, respectively at 0.8 mg/mL as compared to vitamin C (95.2 ± 0.1% at 0.8 mg/mL); in reducing power assay, PE, EE, BE and WE showed reducing power of 0.351 ± 0.017, 1.230 ± 0.034, 0.444 ± 0.014 and 0.818 ± 0.006, respectively at 1mg/mL and compared with vitamin C (0.779 ± 0.032 at 0.1 mg/mL); in linoleic acid peroxidation inhibition assay, PE, EE, BE and WE showed 14.0 ± 1.0, 64.4 ± 2.1, 30.1 ± 1.4, 48.5 ±1.7, rspectively at 1mg/mL and compared with BHT (97.9 ± 2.5 at 1 mg/mL) (Lianhe et al., 2011). The methanol extract of the leaves of *D. paniculata* Roxb. showed superoxide radical, hydroxyl radical, and DPPH radical scavenging activity (Ganga et al., 2012). In speroxide radical scavenging assay, IC_{50} values for the extract and ascorbic acid were 69.3 and 80.2 µg, respectively; in hydroxyl radical scavenging assay, IC_{50} values were 112 and 190.2 µg, respectively and in DPPH scavenging assay, IC_{50} values were 70.6 and 60.24 µg, respectively (Ganga et al., 2012). The methanol extract of the spikes of *D. spinosa* showed potential DPPH radical scavenging activity in a qualitative assay (Bala et al., 2011). The ethanol extract of the bark of *D. latifolia* was investigated for its antioxidant activity using different methods. The extract showed DPPH, NO, and thiocyanate percentage inhibition scavenging activity of 92.10±1.10%, 86.39±2.12%, and 87.22±2.47%, respectiveely. The total phenolic and flavonoid contents of the extract were also reported (Khalid et al., 2011).

Antiplasmodial activity

The flavanoids (*R*)-4-methoxydalbergione (**145**), obtusafuran (**166**), 7,4′-dihydroxy-3′-methoxyisoflavone (**80**) and isoliquiritigenin (**116**) isolated from the heartwood of *D. louvelli* R.Vig. were reported to possess antiplasmodial activity *in vitro* with IC_{50} values ranging from 5.8 to 8.7 um against *Plasmodium falciparum* (Beldjoudi et al., 2003). Antiplasmodial activity was tested based on the inhibition of [^{3}H]-hypoxanthine uptake by *P. falciparum* cultured in human blood, and compared with positive control, chloroquine, showed IC_{50} value of 0.13 µM (Beldjoudi et al., 2003).

Antipyretic activity

The ethanol extract of the leaves of *D. sissoo* showed significant antipyretic activity in a Brewer's yeast-induced pyrexia assay in rats (Hajare et al., 2000). The extract at the doses of 100 and 300 mg/kg showed significant antipyretic activity at 1 h after drug administration while at the 1000 mg/kg showed activity throughout the observation period up to 6 h and results were highly comparable with aspirin (300 mg/kg) (Hajare et al., 2000).

Anti-spermatogenic activity

The anti-spermatogenic efficacy of the ethanol extract of the stem bark of *D. sissoo* showed dose- and time-dependent effects on sperm motility and viability. The Sander-Cramer method was used to assess sperm motility. The extract caused complete immobilization of sperm within 3 minutes at the concentration of 20 mg/mL and at same concentration sperm viability and hypo-osmotic swelling was reduced in significant manner (Vasudeva et al., 2011).

Anti-thrombotic and anti-platelet activities

Two bioactive sesquiterpenes namely (3*S*,6*R*,7*R*)-3,7,11-trimethyl-3,6-epoxy-1,10-dodecadien-7-ol (**209**) and (3*S*,6*S*,7*R*)-3,7,11-trimethyl-3,6-epoxy-1,10-dodecadien-7-ol (**210**) isolated from the essential oil of *D. odorifera*, were investigated for their anti-thrombotic and anti-platelet activities. It was reported that the anti-thrombotic activity of these two compounds was poor, while the anti-platelet activity was strong at both middle (5 µmol/mL) and high (10 µmol/mL) concentrations (Tao et al., 2010). (3*S*,6*R*,7*R*)-3,7,11-trimethyl-3,6-epoxy-1,10-dodecadien-7-ol (**209**) and (3*S*,6*S*,7*R*)-3,7,11-trimethyl-3,6-epoxy-1,10-dodecadien-7-ol (**210**) showed anti-platelet activity with inhibition rate of 15.5 and 9.4%, respectively at 1 µmol/mL; 39.6 and 25%, respectively at 5 µmol/mL; 51.4 and 46.9%, respectively at 10 µmol/mL (Tao et al., 2010).

Anti-ulcerogenic activity

The lyophilized aqueous extract (LAE) of *D. monetaria* L.f. was reported to possess significant anti-ulcerogenic activity in pylorus-ligature, ethanol and hypothermic-restraint stress induced gastric ulcer lesions in Shay rats (Cota et al., 2010). The LAE (89.7 ± 21.5 pg/mg) increased gastric mucosal PGE_2 synthesis in comparision to control (52.6 ± 11.8 pg/mg) in rat stomach assayed by enzyme immunoassay and reduced acid content of gastric juice without modifying P^H in Shay rats, and reduction was highly comparable with cimetidine (Cota et al., 2010).

Cancer chemopreventive activity

Five new cinnamylphenols, dalberatins A (**34**), B (**35**), C (**36**), D (**37**) and E (**38**), isolated from the stem-bark of *D. cultrata* and *D. nigrescens* were reported to have inhibitory activities against EBV-EA (Epstein-Barr virus early antigen) activation induced by TPA (12-*O*-tetradecanoylphorbol-13-acetate) in Raji cells (Ito et al., 2003a). All cinnamylphenols showed inhibitory activity on EBV-EA activation, even at the concentration of 10 mol ratio/TPA (8.3-18.0%) and full blockage of EBV-EA activation occurred at the highest concentration of 1000 mol ratio/TPA without any decrease in viability of the Raji cells (Ito et al., 2003a). IC_{50} values were ranged from 209 to 303 mol ratio/TPA and compared with *β*-carotene, a vitamin A precursor (Ito et al., 2003a).

Diuretic activity

The benzene, alcoholic and aqueous root extracts (75 mg/kg of each) of *D. spinosa* were investigated for their diuretic activity in male albino rats. The alcohol extract showed diuretic activity which was highly comparable with the standard drug furosemide (100 mg/kg) in aspect urinary output and excretion of sodium, potassium and chloride per 6 h (Jaiganesh et al., 2009).

Estrogenic and antiestrogenic activity

Estrogen agonist and antagonist activities of the methanol extract of wood of *D. candenatensis,* were studied using the yeast two-hybrid assay system expressing ERα and ERβ, as well as the extract was also subjected to a naringinase treatment, and retested for their estrogenic activity (El-Halawany et al., 2011). The extract showed estrogenic activity only on ERβ with *β*-galactosidase activity of 206.3±18.2 at the concentration of 100 μg/mL, and while naringinase-treated extract showed 284.2±1.4 at same concentration (El-Halawany et al., 2011). The extract also showed antiestrogenic activity with 42.2±5.0% inhibition of 17*β*-estradiol-induced *β*-galactosidase while tamoxifen showed 78.2±2.4% inhibition (El-Halawany et al., 2011).

Immunomodulating activity

D. monetaria L.f. was evaluated for mitogenic and colony-stimulating factor (CSF)-inducing activities. Orobol 6-*C*-glucoside (**175**) and orobol 8-*C*-glucoside (**176**), isolated from the bark of *D. monetaria*, showed dose dependent CSF-inducing activity at a range of 0.1 to 10 mg/mouse (Kawaguchi et al., 1998). Intraperitoneal injection of orobol 8-*C*-glucoside (**176**) at the dose of 1 mg/mouse increased serum CSF production which reached at peak within 4-6 h, and compared with *Salmonella abortus equi* LPS (1 μg/mouse) (Kawaguchi et al., 1998).

Larvicidal and mosquito repellant activity

The oil extracted through hydro-distillation from the wood scrapings of *D. sissoo* showed dose dependent larvicidal, growth inhibitor and repellent actions against *Anopheles stephensi*, *Aedes aegypti* and *Culex quinquefasciatus* (Ansari et al., 2000). The oil at the lower dosages of 0.4-0.8 mL/m^2 showed 50% mortality after 72 h except against *A. stephensi*, the mortality was 65% after 72 h and at the higher dosages of 4-5 mL/m^2, the mortality was 90-100% against *A. aegypti* and *C. quinquefasciatus* but mortality was 60-85% against *A. stephensi* and results were compared with commercial 'Mylol' oil (Ansari et al., 2000). No adult emergence was observed at the dose of 4 mL/m^2 against *A. stephensi*, *A. aegypti* and *C. quinquefasciatus*, while no fertility was found at the dose of 2 mL/m^2 (Ansari et al., 2000). The repellent action was ranged from 89.7 ± 3.1 to 100% against tested species namely *Anopheles culicifacies* (96.11 ± 6.6), *Anopheles annularis* (100.00 ± 0.0), *Anopheles subpictus* (89.7 ± 3.1) and *C. quinquefasciatus* (91.7 ± 2.2) and compared with Mylol oil (Ansari et al., 2000). The ethanol extract and the aqueous methanol and hexane fractions of the bark of *D. saxatilis* were reported to have almost equal insecticidal activity against adult mosquitoes at 0.2% concentration in the first 30 min of application as compared to solvent as control but ethyl acetate fraction showed less activity than other fractions (Okwute et al., 2009).

Osteogenic activity

A new isoflavone glucoside, caviunin 7-*O*-[*β*-D-apiofuranosyl-(1→6)-*β*-D-glucopyranoside] (**28**) and four known compounds namely genstein (**95**), biochanin A (**2**), pratensein (**180**) and biochanin 7-*O*-glucoside (**5**), isolated from the leaves of *D. sissoo*, showed osteogenic activity in primary calvarial osteoblast cultures. These compounds showed increased alkaline phosphatase activity and mineralization, which substantiated potential osteogenic activity (Dixit et al., 2012). All the compounds at the concentrations ranging from 1 pM to 1 μM applied to calvarial osteoblast cells to screen alkaline phosphatase activity as well as stimulatory activity of those compounds on osteoblast formation mediated via estrogen receptor (ER) was studied (Dixit et al., 2012). It was found that differentiation of osteoblast formation was ER independent. Caviunin 7-*O*-[*β*-D-apiofuranosyl-(1→6)-*β*-D-glucopyranoside] (**28**), genstein (**95**), pratensein (**180**) and biochanin 7-*O*-glucoside (**5**), failed to inhibit ALP production except mild response from biochanin A (**2**) (Dixit et al., 2012). Biochanin A (**2**) inhibited osteoblast formation at the concentration of 10 nM in the presence of ICI-182780 (anti-estrogen). All tese five compounds also induced the formation of mineralized nodules in osteoblast cultures and in all studies control was untreated cells (Dixit et al., 2012). Caviunin 7-*O*-[*β*-D-apiofuranosyl-(1→6)-*β*-D-glucopyranoside] (**28**) showed most potent osteogenic activity than the four known compounds (Dixit et al., 2012).

Protective activity

Several compounds namely 4,2′,5′-trihydroxy-4′-methoxychalcone (**204**), (2*S*)-6,4′-dihydroxy-7-methoxyflavan (**81**), 6,4′-dihydroxy-7-methoxyflavanone (**82**), *R*(+)-4-methoxydalbergione (**145**), *R*(-)-latifolin (**129**), *R*(+)-dalbergiphenol (**39**), 9-hydroxy-6,7-dimethoxydalbergiquinol (**104**) and isoparvifuran (**117**) isolated from the heartwood of *D. odorifera* were reported to show a protective effect on glutamate-induced oxidative injury in HT22 cells (An et al., 2008). All these compounds were tested at the concentrations of 1, 10, 20 and 50 μM and compared with trolox (positive control). EC_{50} values were of 7.47, 2.85, 3.3, 8.54, 5.82, 6.54, 8.14 and 3.09 μM, respectively for compounds as mentioned above and trolox showed EC_{50} value of 15.8 μM (An et al., 2008).

Tyrosinase inhibition

Tyrosinase (E.C. 1.14.18.1) is a Cu-containing enzyme, and it is mainly involved in biosynthesis of melanin. It catalyzes the initial two steps in biosynthesis of melanin, which includes the hydroxylation of L-tyrosine and the oxidation of its product, the L-DOPA (diphenolase activity), to the corresponding *O*-quinone (Kang et al., 2005). In mammals, this enzyme is responsible for skin pigmentation abnormalities such as flecks and defects. Tyrosinase is also associated with Parkinson’s and related neurodegenerative diseases (Nithitanakool et al 2009) by oxidizing dopamine to generate DOPA quinones, which are highly reactive compounds inducing neuronal damage and cell death. Interestingly, isoliquiritigenin (**116**), which is a constituent of *D. odorifera* and *D. louvelii* is reported to possess significant tyrosinase inhibition (IC_{50} value: 61.4 μM, Kang et al., 2005). Molecular docking studies usi-

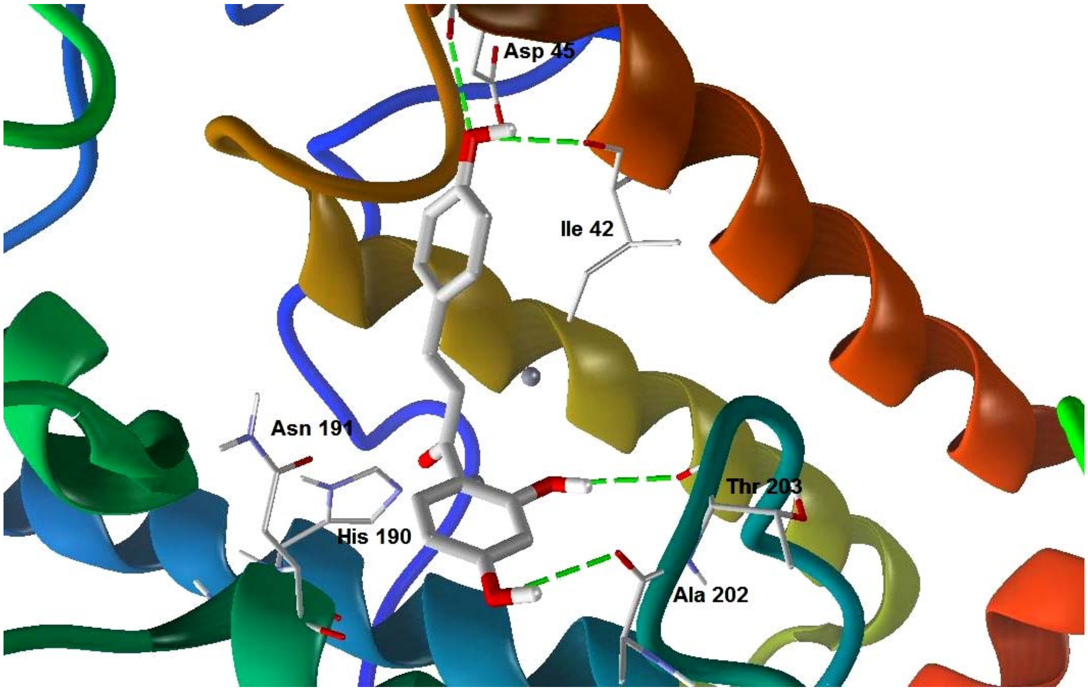


Figure 1. Binding mode of isoliquiritigenin inside catalytic site of tyrosinase. Hydrogen bonds are depicted as dotted lines.

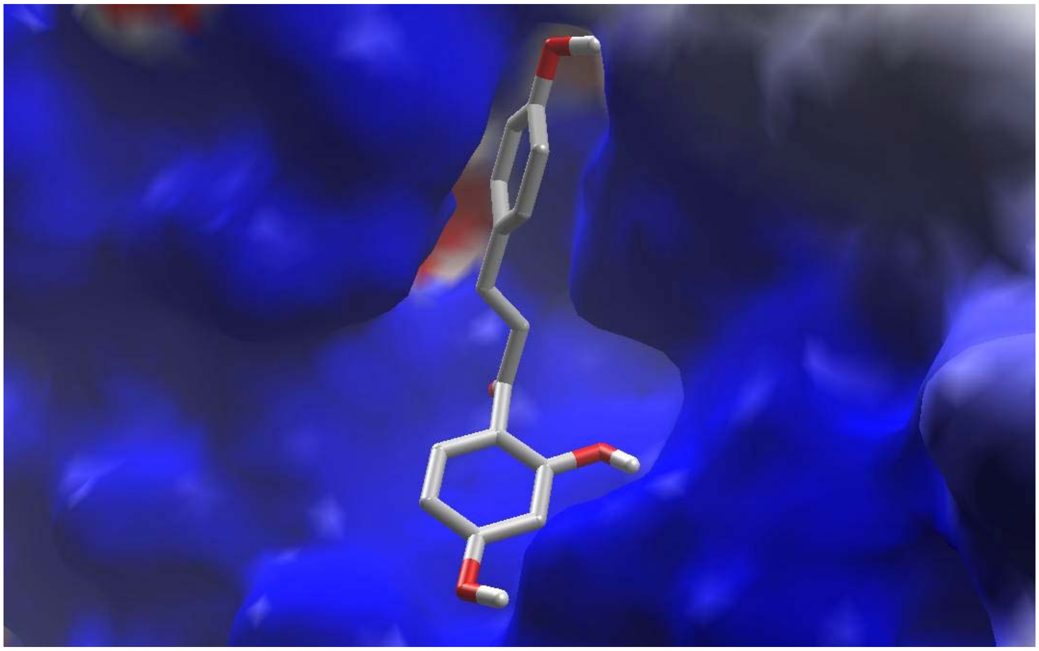


Figure 2. Steric and electrostatic interactions of isoliquiritigenin with tyrosinase (PDB: 1WX2). Blue color indicates positive electrostatic surface, red color regions indicate negative electrostatic surface, and white regions depict non-polar (hydrophobic) surface of the enzyme.

ng Gold Software revealed significant molecular interactions between the active site of tyrosinase and isoliquiritigenin. Simultaneous hydrogen bonding between terminal phenolic group of isoliquiritigenin was found in close favorable contact with Asp 46 and Ile42 of enzyme active site (Figure 1). On other side, phenolic moieties at position 2′ and 4′ were observed to be favorably interacting with Thr 203 and Ala 202 of tyrosinase. Isoliquiritigenin seems to be sterically and electrostatically favorable inhibitor for tyrosinase (Figure 2). Future work on modification of isoliquiritigenin will lead development of new lead compounds for treatment of diseases associated with abnormal function of tyrosinases.

Uterine muscle contracting activity

A saponin isolated from the roots of *D. saxatilis* was investigated for uterine muscle contracting activity in rats. Activity was demonstrated in a concentration dependent manner with an ED_{50} value of 0.13 mg/mL (Uchendu et al., 1999a). The saponin at the concentration of 0.04 mg/mL was sufficient to initiate forceful contractions of a quiescent uterine muscle strip and concentrations ranging from 0.08 to 0.36 mg/mL produced transient single contractions associated with onward increase in the amplitude of contractions as well as frequency of spikes within each burst and carbachol was positive control which also caused dose-dependent uterine muscle contraction with ED_{50} value of 2.31 µmol and lowest active concentration was 0.30 µmol (Uchendu et al., 1999a). A triterpenoid glycoside dalsaxin, isolated from the roots of *D. saxatilis*, showed dose dependent uterine muscle contracting activity by stimulating post-junctional alpha 2-adrenergic receptors by inhibiting plasma membrane adenylate cyclase system associated with the increase in intracellular cAMP content (Uchendu et al., 1999b). Adrenaline (9.10 nmol) reversibly decreased (92.6%) myometrial contraction stimulated by dalsaxin (0.24 mg/mL) and atipamezole (1.50 ng/mL) also reduced (80%) myometrial contraction but prazosin (7.72-15.60 nmol) failed (Uchendu et al., 1999b). Response of dalsaxin (0.24 mg/mL) to uterine muscle increased by propranolol (beta-adrenergic receptor anatagonist) (Uchendu et al., 1999b).

Toxicity

An acute toxicity study showed that the ethanol bark extract of *D. sissoo* was non-toxic up to 3000 mg/kg body weight in Swiss Albino mice (Asif et al., 2011). A decoction of the stem bark of *D. subcymosa* Ducke was investigated for embryo-fetotoxicity effects and disturbance of postnatal development of pups in female rats (Peters et al., 1995). The decoction (40 mg/rat) was given to female rats on days 6-15 of pregnancy by gastric intubation and compared with control received distilled water (0.5 mL/rat). Maternal, fetal and newborn studies suggested that the decoction has no embryo-fetotoxicity and disturbance of postnatal development of pulps in female rats (Peters et al., 1995).

Discussion

The aim of our review was to compile the phytochemical and pharmacological works on the plants of *Dalbergia* genus that have been done so far. Our investigation revealed that a good number of reports are available on the plants of this genus. This indicates that the plants from *Dlabergia* genus have been an interesting choice for the researchers to investigate for either their medicinal value or secondary metabolite content. World wide distribution of these plants might have eased the collection process of the plant material. Although the plants are native to tropical and subtropical regions of the world, these plants have been naturealized in different parts of the world due to their commercial value. Use of these plants in ethnomedicinal practice might also have acted as a factor for pharmacological investigation or bioassay guided phytochemical investigation. Ethnomedicinal uses of these plants are often specific to certain diseases. Most of the plants are used in various forms of pain, rheumatism, gonorrhea, stomach disorders and blood disorders (Ghani, 1999; Kang et al., 2005; Khare, 2007; Hou et al., 2011). We found that only thirty four plants have been investigated so far for their phytochemical contents. On the other hand, twenty eight biological activities have been reported. Antioxidant activity study is the highest screened activity. The virtue of this plant to synthesize phenolic compounds including flavonoids made them attractive natural source for antioxidant activity study. Antiinflammatory, antimicrobial and anticancer are the other assays that have been done in a considerable extent. Bioassy study also revealed some interesting activity including antiplatelet, antithrombic, antifertility, antispermatogenic, and antiplasmodial activity. Such activities are indeed important finding since development of novel agents for the management of aforementioned cases are a dire need. Bioactive compounds were reported only from twelve plants. In some cases, mechanism of action in molecular level has also been pinned down. Despite this limited number of plants being investigated; such investigations led to the identification of a good number of active compounds. Some of these compounds are exclusively found in this genus. Most of the active compounds are flavones with pyran or furan ring, isoflavone, neoflavone and chalcones. Onle a few of the active compounds are simple phenolics, styrene derivatives, cimmanyl phenols, fatty acid derivatives or sesquiterpenes. Pure phytochemical investigation also led to the discovery of molecules that are considered important due to their diverse role in biolo-gical processes. Some of these well known compounds belong to the class of flavonoids, isoflavonoids, neoflavonoids and chalcones and are abundant in this genus. Such copounds already drew the attention of the researchers for their ability to ameliorate or prevent condit-ions including cancer, diabetes, neurodegeneration and oxidative damages. Therefore, there is a good opportunity to exploit plants of this genus as a good source of neutraceuticals.

Conclusion

The number of plants cited above may vary to some extent as some more works might have published at the time of the publication of this article or articles published but are not available on internet. Still, our present investigation suggests that this only a few plants of this genus have been investigated so far for bioactive compounds. The use of the plants of this genus in ehtnomedicinal practice coupled with rich secondary metabolite content made this genus a true natural product resource for the investigation of biological activities as well as bioassay guided phytochemical investigation which can lead to the discovery of novel structures with potential therapeutic value. As a common phenomenon with natural product research, it is possible that some known compounds might end up as the active compounds. At this point we do recommend for conventional bioassay guided investigation since some of the well known and easily available compounds can prove valuable in the treatment of disease for which still no good cure is known.

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Conflict of interest

There is no conflict of interest associated with the authors of this paper.

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