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REVIEW

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Traditional uses, phytochemistry, and pharmacology of genus *Vitex* (Lamiaceae)

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Vitex, the genus of the family Lamiaceae, comprises of about 230 species mostly distributed in the warm regions of Europe and temperate regions of Asia. Several *Vitex* species have been used as folk medicine in different countries for the treatment of various kinds of diseases and ailments. The main aim of this review is to collect and analyze the scientific information available about the *Vitex* species regarding their chemical constituents and pharmacological activities. The phytochemical investigation of various *Vitex* species has resulted in the isolation of about 556 chemical constituents belong to various chemical category *viz*. iridoids, diterpenoids, triterpenoids, flavonoids, lignans, sesquiterpenoids, monoterpenoids, ecdysteroids, and others. The crude extracts of different *Vitex* species as well as pure phytochemicals exhibited a wide spectrum of *in-vitro* and *in-vivo* pharmacological activities. In the present review, the scientific literature data on the ethnopharmacological, phytochemical, and pharmacological investigations on the genus *Vitex* are summarized. More attention should be given in future research to evaluate the pharmacological potential with detailed mechanism of actions for the pure compounds, extracts of plants from this genus. Moreover, their clinical study is needed to justify their use in modern medicine and to further exploring this genus for new drug discovery.

KEYWORDS
Vitex, ethnobotany, phytochemistry, pharmacology, *Vitex negundo*

1 | INTRODUCTION

The genus *Vitex*, consisting of ca. 230 species, belongs to the Lamiaceae family. Its species are mostly distributed in the warm regions of Europe and temperate regions of Asia. The majority of the species are either trees or aromatic shrubs. A number of *Vitex* species have been used as traditional medicine in different countries for the treatment of various diseases and ailments. In India, mainly *Vitex agnus-castus* L., *Vitex negundo*, *Vitex peduncularis* Wall. ex Schauer, *Vitex pubescens* Vhal, and *Vitex trifolia* L. are found throughout the country (Chopra et al. 1992). The fruits and leaves of *V. agnus-castus* have been used mainly in traditional medicine. The fruits are given to the females to treat diseases like menstrual disorders, premenstrual dysphoric disorder, hyperprolactinemia infertility, acne, menopause, disrupted lactation, breast pain, cyclical mastalgia and inflammatory conditions, diarrhea, and flatulence, and leaves are used for increasing milk (Azadbakht, Baheddini, Shorideh, & Naserzadeh, 2005; Odenthal, 1998). The leaves and fruits of *V. negundo* L. have been used in folk medicine for the treatment of asthma, chronic bronchitis, cold, headache, migraine, gastrointestinal infections, catarrhal fever, dysmenorrhea, and as an anthelmintic (Tirtha, 1998; Liu, Tseng, & Yang, 2004). The infusions of leaves, root bark, or young stem bark of *V. peduncularis* Wall. ex Schauer are useful in malarial and black water fever (Chopra et al., 1992). The *Vitex rotundifolia*

L.f. is widely used as folk medicine in Japan for headache, colds, migraine, eye pain, etc (Kimura & Kimura, 1980). The *V. trifolia* L. has been used as an anti-inflammatory and sedative agent for the treatment of headache, rheumatism, and the common cold in Asian countries (Kimura, 1996). The Iridoids, diterpenoids, triterpenoids, flavonoids, and lignans are the major bioactive principles of the *Vitex* species.

Previously, a collection of 108 references on the genus *Vitex* and its phytochemistry, ethnopharmacology, morphology, pharmacological reports, clinical studies, and toxicology were reviewed in 2013 by Rani and their co-workers (Rani & Sharma, 2013). In this present review, we have summarized systematically the literature data on the phytochemical, ethnopharmacological, and pharmacological investigations on the genus *Vitex* up to December 2020.

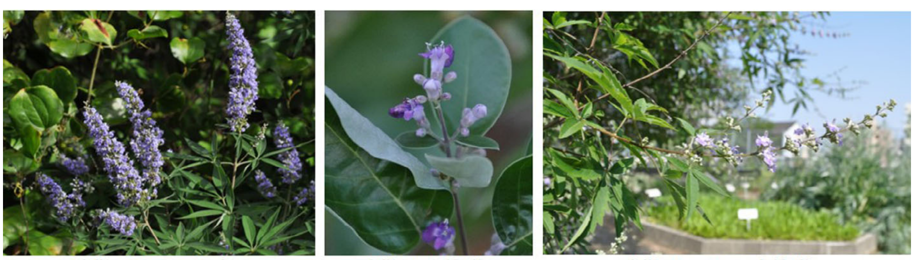
2 | METHODOLOGY

The main literature search was conducted via SciFinder (http://cas.org/products/scifinder/index.html) covering period up to December 2020. Additional information was collected from PubMed (http://www.ncbi.nlm.nih.gov/pubmed), Science Direct, Google Scholar, and different journals and books. The keywords like genus *Vitex*, ethnobotany of *Vitex*, phytochemistry of *Vitex*, pharmacology of *Vitex*, etc., have been used while searching using the database.

3 | TRADITIONAL USES OF PLANTS BELONGING TO GENUS *VITEX*

Vitex genus comprises about 230 species distributed all over the world (Mabberley, 1997). Several species of *Vitex* have long been used in traditional medicines in different countries. The photographs of few species are given in Figure 1.

In Iranian traditional medicine, the leaves and fruits of *V. agnus-castus* are used by women for increasing breast milk (Azadbakht et al., 2005). The fruits (Chaste berry) of this plant have been used as a dietary supplement in many countries of the Mediterranean region and Southern Europe for the treatment of hormonal imbalance syndrome in women. The fruits either as a fluid extract or dried fruits have been used in pills for 4–6 months for the treatment of many disorders including corpus luteum insufficiency, hyperprolactinemia, infertility, menstrual disorders, premenstrual dysphoric disorder, menopause, disrupted lactation, and cyclical mastalgia (Dugoua, Seely, Perri, et al., 2008; Atmaca, Kumru, & Tezcan, 2003). The bark, fruits, and leaves of *Vitex diversifolia* Kurz are used in Andaman and India for the treatment of skin diseases, intestinal troubles, and amoebiasis (Bibi, Thangamani, & Venkatesalu, 2016). In Burkina Faso, the raw fruits of *Vitex doniana* Sweet are consumed to suppress the appetite (Pare, Hilou, Ouedraogo, & Guenne, 2016), In India, the Kani tribes of Kerala have been using the decoction or juice of *V. trifolia* L. for the treatment of wounds and ulcers (Xavier, Kannan, Lija, et al., 2014). In India, the decoction or tincture of the roots of *V. negundo* L. is used in dyspepsia, colic pain, dysentery, asthma, bronchitis and other respiratory disorders, and skin diseases (Ross, 2005) (Muthu, Ayyanar, Raja, & Ignacimuthu, 2006) (Rajadurai, Vidhya, Ramya, & Bhaskar, 2009), stem decoction is used in burns (Ladda & Magdum, 2012), the decoction of flowers is used in cholera and liver disorders (Pattanaik, Sudhakar Reddy, & Murthy, 2008), and leaf decoction is used in wounds, ulcers, and as a diuretic (Kirtikar & Basu, 1984). In Malaysia, the leaf and shoot juice are used in gynaecological disorders and as galactogogne (Tandon, Khajuria, Kapoor, et al., 2008). In Sri Lanka, the powdered root, tincture from root and bark, and fresh leaf juice of *V. negundo* are used in rheumatism (Kirtikar & Basu, 1984). In China, fresh leaf juice of *V. negundo*. is used to treat gout (Woradulayapinij, Soonthornchareonnon, & Wiwat, 2005). In Pakistan, the leaves are used as antiallergic (Zabihullah, Rasheed, & Akhtar, 2006). In Bangladesh, the roots and whole plant are used to treat malaria, and leaf decoction along with long pepper is used to treat catarrhal fever (Khan & Manzoor Rashid, 2006). In Philippines, the stem-bearing flowers are used in cancer (Graham, Quinn, Fabricant, & Farnsworth, 2000). In Maldives, the decoction of the leaf is used for the treatment of febrile, catarrhal, and rheumatic problems (Sujanapal & Sankaran, 2016). In Guimaras Island, Philippines, the decoction of leaves of *V. trifolia* subsp. *litoralis* stems is drunk for treatment of cough with phlegm and postpartum recovery (Ong & Kim, 2014). In Japan and China, the fruits of *V. trifolia* are used for colds and headaches, migraines, eye pain, and inflammation (Kimura & Kimura, 1980). In Tonga, an infusion of leaves is given to infants to treat mouth infections and stomachache (Whistler, 1992). In Bangladesh, the flowers of *V. trifolia* are prescribed to treat fevers accompanied with vomiting. In Fiji, the leaves of *V. trifolia* are used to treat coughs, gonorrhea, stomach pain, and wounds (Weiner, 1983). In Madagascar, the infusion of *V. trifolia* stems and leaves is used before meals to relieve stomach pain (Boiteau & Allorge-Boiteau, 2000). In Thailand, the decoction of *V. trifolia* L. flowers is used as a tea to alleviate asthma (Panthong,



Vitex negundo *Vitex trifolia* *Vitex cannabifolia*

FIGURE 1 Photographs of some *Vitex* species flowers

Kanjanapothi, & Taylor, 1986). In Futuna, South Pacific Island, *V. trifolia* leaves are chewed with leaves of *Citrus sinensis* (orange tree) to relieve pain in sore tooth (Whistler, 1992). In Hawaii, the crushed leaves of *V. rotundifolia* are used as an antiitch remedy and heal rashes (Whistler, 1992). A decoction of seeds and fruits of *V. rotundifolia* L.f. is taken orally in Korea, Japan, and China for colds, headaches, migraine, sore eyes, night blindness, myalgia, and neuralgia (But, 1996; Shin, Kim, Lim, et al., 2000). In India, the bark of *V. peduncularis* Wall. ex Schauer is used topically on the chest to alleviate chest pain (Kirtikar & Basu, 1984). Both bark and fruit of *Vitex polygama* Cham. are used in Brazil as emmenagogues and diuretics (Correa, 1926). The infusions from the boiled leaves of *Vitex lucens* are used by the Maori of New Zealand to treat sprains, backaches, sore throats, and ulcers (Brooker, Cambie, & Cooper, 1987). In Mexico, the *Vitex mollis* Kunth is used to treat dysentery, scorpion stings, diarrhea, and stomachaches (Argneta, Cano, & Rodarte, 1994).

4 | PHYTOCHEMISTRY

The genus *Vitex* is comprehensively studied for its chemical constituents, and till date 556, chemical compounds belonging to different chemical classes from various species have been reported. These phytochemicals mainly include iridoids, diterpenoids, triterpenoids, flavonoids, lignans, sesquiterpenoids, monoterpenoids, ecdysteroids, and miscellaneous compounds. Out of the reported 556 compounds, 37 are iridoids (**1–37**) (Table 1), 143 are diterpenoids (SI. No. **38–181**) (Table 2), 71 are triterpenoids (**182–252**) (Table 3), 99 are flavonoids (**253–351**) (Table 4), 75 are lignans (**352–426**) (Table 5), 26 are sesquiterpenoids (**427–452**) (Table 6), 16 are monoterpenoids (**453–468**) (Table 7), 27 are ecdysteroids (**469–495**) (Table 8), and 61 belong to other classes of compounds (**496–556**) (Table 9). Many of the isolated compounds were evaluated for their biological activities.

With respect to the isolated phytochemicals of the genus *Vitex*, the leaves, fruits, and seeds were the most common targets of investigation of the plants for isolation of bioactive principles and most of these compounds are reported from *V. negundo*, *V. agnus-castus*., *V. trifolia* L., *V. cannabifolia* Siebold & Zucc., and *V. rotundifolia* L.f. Iridoids, diterpenoids, triterpenoids, flavonoids, and lignans are the major bioactive principles of the *Vitex* species. Different species studied for their chemical constituents were the following: *V. negundo* L., *V. agnus-castus*., *V. trifolia* L., *V. cannabifolia* Siebold & Zucc., *V. rotundifolia* L.f., *V. altissima* L., *V. leptobotrys* Hallier f., *V. peduncularis* Wall. ex Schauer, *V. polygama* Cham., *V. cienkowskii* Kotschy & Peyr., *V. quinata* F.N.Williams, *V. limonifolia* Wall. ex C.B. Clarke, *V. cymosa* Bertero ex Spreng., *V. cauliflora* Moldenke, *V. pinnata* L., *V. doniana* Sweet, *V. scabra* Wall. ex Schauer, *V. vestita* Wall. ex Schauer, *V. simplicifolia* Oliv., *V. strickeri* Vatke & Hildebr., *V. canescens* Kurz, *V. rivularis* Gürke, *V. pseudo-negundo* var. *pseudonegundo Hausskn* (synonym of *Vitex agnus-castus* L.), *V. cofassus* Reinw. ex Blume, *V. rehmannii* Gürke, *V. mollis* Kunth, *V. rotundiforia*, *V. glabrata* R.Br., *V. kwangsiensia* C. Pei, *V. pubescens* Vahl, and *V. gardneriana* Schauer.

5 | PHARMACOLOGICAL ACTIVITIES

The pharmacological activities of crude extracts/pure isolates from several species of *Vitex* have been reported. Here, some of the important pharmacological activities are discussed in following sections.

5.1 | In-vitro experiments

5.1.1 | Anti-inflammatory activity

The iridoid agnuside (**3**) isolated from the *n*-BuOH extract of *V. peduncularis* stem bark showed significant anti-inflammatory activity by inhibiting the activity of proinflammatory enzymes, COX-2 with IC_{50} value of 0.026 ± 0.015 mg/ml, while it showed mild inhibitory effects on COX-1 (Suksamrarn, Kumpun, Kirtikara, et al., 2002a).

The flavonoid casticin (**292**) also known as vitexicarpin isolated from *V. rotundifolia* showed anti-inflammatory activity by preventing TNF-α-induced vascular inflammatory process in human umbilical vein endothelial cells (HUVEC) model (S. M. Lee et al., 2012).

The diterpene, viterotulin A (**47**), and the neolignan viterolignan A (**380**) isolated from *V. rotundifolia* showed anti-inflammatory activity by inhibiting NO production in LPS-induced RAW 264.7 macrophages with IC_{50} values of 16.4 and 21.1 μM, respectively (C. Lee et al., 2013).

A lignan, negundin B (**367**) isolated from *V. negundo* roots exhibited potent anti-inflammatory activity by inhibiting the activity of soybean lipoxygenase and butyryl-cholinesterase (BChE) with IC_{50} of 6.25 ± 0.5 and 194 ± 4.4 μM, respectively. While another isolated lignan, vitrofolal E (**365**) isolated from the same plant showed moderate activity against BChE with IC_{50} of 35.0 ± 105 μM (Azadbakht et al., 2005).

The labdane diterpenes, negundoin C (**69**) and E (**71**) isolated from *V. negundo* seeds showed anti-inflammatory effects by inhibiting NO production by LPS-stimulated RAW 264.7 macrophages, with IC_{50} values of 0.12 and 0.23 μM, respectively. Further studies revealed that these compounds at 5 μM concentration significantly reduced the levels of iNOS proteins to 0.40 ± 0.13% and 41.01 ± 6.02%, respectively, and Cox-2 protein to 2.06 ± 0.53% and 26.40 ± 7.43%, respectively (Zheng, Huang, Wang, et al., 2010).

A significant *in-vitro* anti-inflammatory activity against neutrophil elastase was presented by hexane extracts from *V. mollis* (leaf IC_{50} = 235 μg/ml and stem IC_{50} 446 = μg/ml) (Morales-Del-Rio, Gutiérrez-Lomelí, Robles-García, et al., 2015). Negundoin G, a terpene, isolated from seeds of *V. negundo* L. var. *heterophylla* significantly reduced the nitric oxide production (IC_{50} 0.71 ± 0.16 μM) in murine microglial BV-2 cells induced by lipopolysaccharide (Hu et al., 2016).

The flavonoid vitexin (**264**) reduces neutrophil migration to inflammatory focus by down-regulating proinflammatory mediators

TABLE 1 List of iridoids reported from different species of *Vitex* and their biological activities

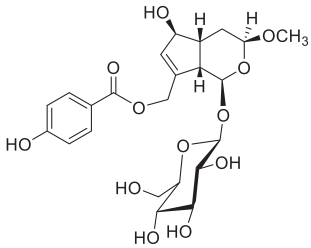
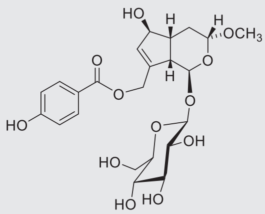
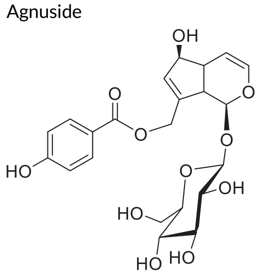
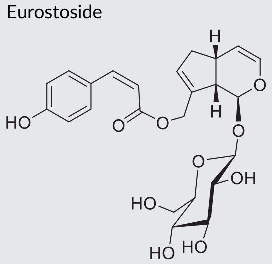
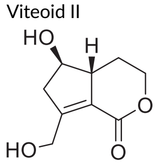
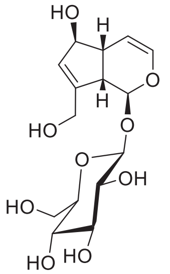
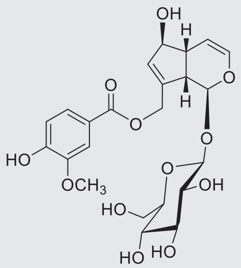
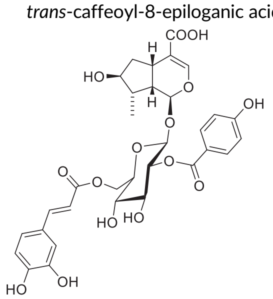
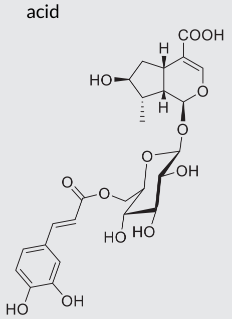
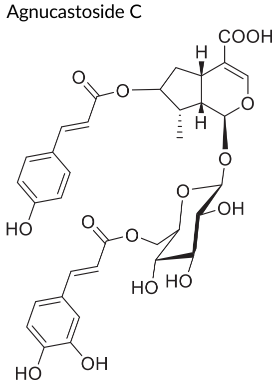
Compound No.	Compound name	Plant source	Plant part/extraction solvent/fraction	Biological activity	References
1	Nishindaside 	*V. negundo*	Leaves/EtOH extract, *n*-BuOH fraction		(Dutta, Chowdhury, Chakravarty, et al., 1983)
		V. cannabifolia	Fruit/MeOH extract	Free radical scavenging activity.	(Yamasaki, Kawabata, Masuoka, et al., 2008)
			Leaves/MeOH extract, *n*-BuOH fraction		(Iwagawa, Nakahara, & Nakatani, 1993)
		V. rotundifolia	Fruit/EtOH extract/ EtOAc fraction		(Wu, Zhang, & Yin, 2010)
2	Isonisindaside 	*V. cannabifolia*	Leaves/MeOH extract, *n*-BuOH fraction		(Iwagawa et al., 1993)
3	Agnuside 	*V. agnus-castus*	Fruit/MeOH extract		(Görler, Öhlke, & Soicke, 1985)
			Leaves		(Winde & Hänsel, 1960)
			Leaves/MeOH extract		(Kouno, Inoue, Onizuka, et al., 1988)
		V. rotundifolia	Fruit/MeOH extract		(Ono, ITO, Kubo, & Nohara, 1997)
			Fruit/EtOH extract/ EtOAc fraction		(Wu et al., 2010)
		V. agnus-castus	Flowering stems/ MeoH extract		(Kuruüzüm-Uz, Ströch, Demirezer, & Zeeck, 2003)
		V. altissima	Leaves/EtOAc extract		(Sridhar, Subbaraju, Venkateswarlu, & Venugopal, 2004)
			Plant/MeOH extract		(Ramírez-Cisneros, Rios, Aguilar-Guadarrama, et al., 2015)
		V. mollis	Seeds/95% EtOH extract		(Arai, Fujimatsu, Uchida, et al., 2013)
		V. negundo	Whole plant/MeOH extract/EtOAc fraction		(Sathiamoorthy, Gupta, Kumar, et al., 2007)
			Leaves/EtOH extract		
		V. trifolia	Leaves/MeOH extract, *n*-BuOH fraction		(Tiwari, Thakur, Saikia, et al., 2013)
4	Eurostoside 	*V. rotundifolia*	Leaves/MeOH extract		(Kouno et al., 1988)
5	Viteoid II 	*V. rotundifolia*	Fruit/MeOH extract		(Ono et al., 1997)

TABLE 1 (Continued)

Compound No.	Compound name	Plant source	Plant part/extraction solvent/fraction	Biological activity	References
6	Aucubin 	*V. agnus-castus*	Flowering stems/ MeOH extract		(Kuruüzüm-Uz et al., 2003)
			Fruit/*n*-hexane extract		(S. Li, Qiu, Yao, et al., 2013)
7	10-*O*-Vanilloyl aucubin 	*V. cannabifolia*	Fruit/MeOH extract		(Yamasaki et al., 2008)
		V. rotundifolia	Fruit/EtOH extract/ EtOAc fraction		(Wu et al., 2010)
8	2′-*O*-*p*-Hydroxybenzoyl-6′-O-*trans*-caffeoyl-8-epiloganic acid 	*V. altissima*	Leaves/EtOAc extract	Potent antioxidant activity as measured using superoxide (NBT riboflavin photoreduction) free-radical-scavenging method with IC_{50} value 31.9 μM and DPPH-radical-scavenging method with IC_{50} value 11.4 μM.	(Sridhar et al., 2004)
9	2′-*O*-*p*-Hydroxybenzoyl-8-epi-loganic acid 	*V. altissima*	Leaves/EtOAc extract		(Sridhar et al., 2004)
10	Agnucastoside C 	*V. agnus-castus*	Flowering stem/MeOH extract		(Kuruüzüm-Uz et al., 2003)

(Continues)

TABLE 1 (Continued)

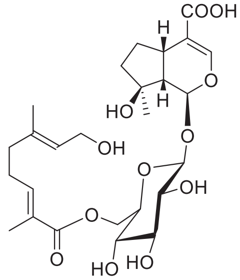
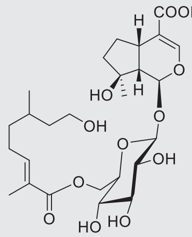
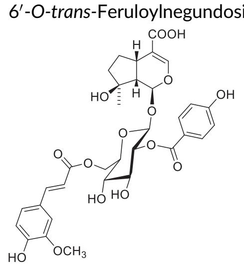
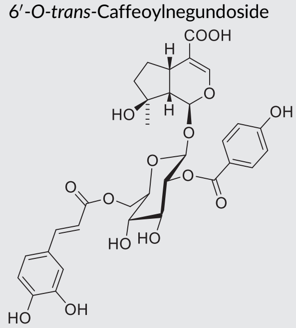
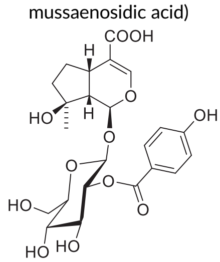
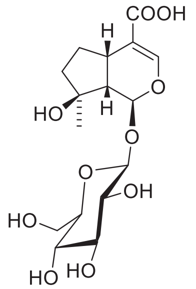
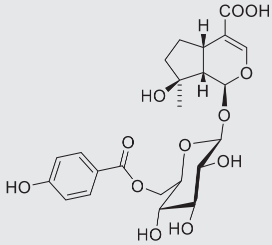
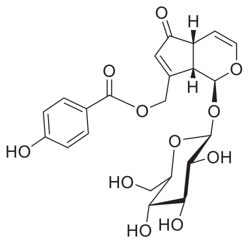
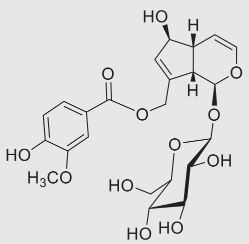
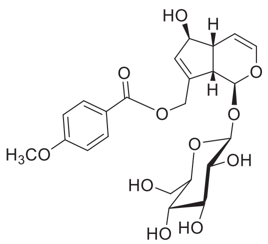
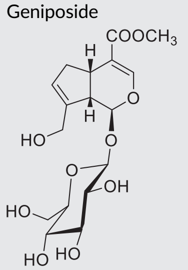
Compound No.	Compound name	Plant source	Plant part/extraction solvent/fraction	Biological activity	References
11	Agnucastoside A 	*V. agnus-castus*	Flowering stem/MeOH extract		(Kuruüzüm-Uz et al., 2003)
12	Agnucastoside B 	*V. agnus-castus*	Flowering stem/ MeOH extract		(Kuruüzüm-Uz et al., 2003)
13	6′-*O*-*trans*-Feruloylnegundoside 	*V. altissima*	Leaves/EtOAc extract		(Sridhar et al., 2004)
14	6′-*O*-*trans*-Caffeoylnegundoside 	*V. altissima*	Leaves/EtOAc extract	Potent antioxidant activity as measured using superoxide (NBT riboflavin photoreduction) free-radical-scavenging method with IC_{50} value 24.3 μM and DPPH-radical-scavenging method with IC_{50} value 15.2 μM.	(Sridhar et al., 2004)
15	Negundoside (2′-*p*-Hydroxybenzoyl mussaenosidic acid) 	*V. negundo*	Leaves/EtOH extract	Antifungal activity against *T. mentagrophytes* and *C. neoformans* with MIC 6.25 μg/ml	(Arai et al., 2013)
		V. altissima			(Sathiamoorthy et al., 2007)
		V. trifolia	Leaves/EtOH extract		(Sridhar et al., 2004) (Sehgal, Taneja, Dhar, et al., 1982)
			Leaves/MeOH extract, *n*-BuOH fraction		(Tiwari, Thakur, et al., 2013)

TABLE 1 (Continued)

Compound No.	Compound name	Plant source	Plant part/extraction solvent/fraction	Biological activity	References
16	Mussaenosidic acid 	*V. agnus-castus*	flowering stems/ MeOH extract		(Kuruüzüm-Uz et al., 2003)
		V. trifolia	Leaves/MeOH extract, *n*-BuOH fraction		(Tiwari, Thakur, et al., 2013)
17	6′-*O*-*p*-Hydroxybenzoylmussaenosidic acid 	*V. agnus-castus*	Flowering stems/ MeOH extract		(Kuruüzüm-Uz et al., 2003)
		V. negundo	Leaves/EtOH extract		(Sehgal, Taneja, Dhar, et al., 1983)
		V. trifolia	Leaves/MeOH extract, *n*-BuOH fraction		(Tiwari, Thakur, Saikia, et al., 2013)
18	Agnusoside 	*V. agnus-castus*	Flowers/MeOH extract, H_2O fraction		(Kırmızıbekmez & Demir, 2016)
19	Pedunculariside 	*V. peduncularis*	Stem bark/*n*-BuOH		(Suksamrarn, Kumpun, Kirtikara, et al., 2002a)
20	Limoniside 	*V. limonifolia*	Bark/EtOH extract		(Suksamrarn, Kumcharoen, & Suksamrarn, 1999)
21	Geniposide 	*V. cannabifolia*	Fruit/MeOH extract	DPPH free radical scavenging activity	(Yamasaki et al., 2008)

(Continues)

TABLE 1 (Continued)

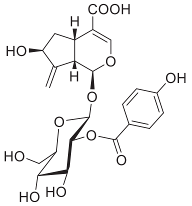
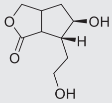
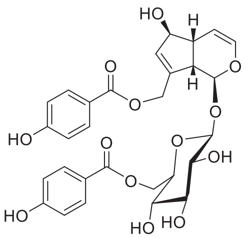
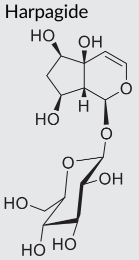
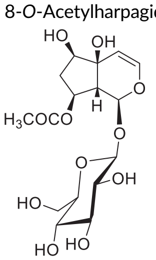
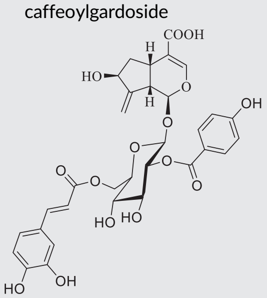
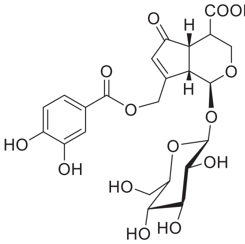
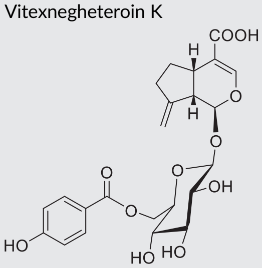
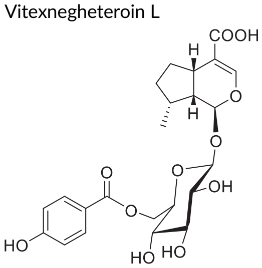
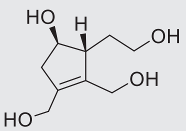
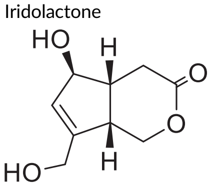
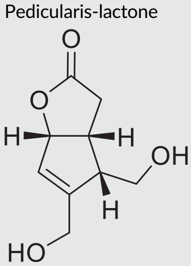
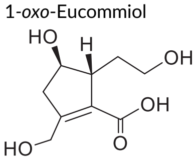
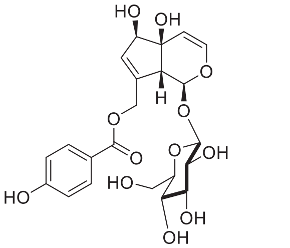
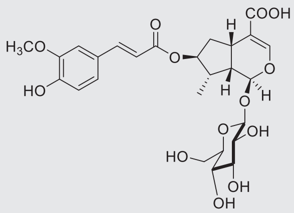
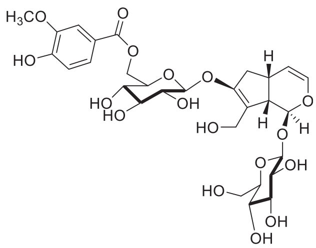
Compound No.	Compound name	Plant source	Plant part/extraction solvent/fraction	Biological activity	References
22	2′-*O*-*p*-Hydroxybenzoyl gardoside 	*V. altissima*	Leaves/EtOAc extract		(Sridhar et al., 2004)
23	Viteoid I 	*V. rotundifolia*	Fruit/MeOH extract		(Ono et al., 1997)
24	10-*p*-Hdroxybenzoyl-6β-hydroxyiridoid 1-*O*-β-D-(6′-*O*-*p*-hydroxybenzoyl)-glucopyranoside 	*V. negundo*	Leaves/70% EtOH extract		(Qiu, Tong, Yuan, et al., 2016)
25	Harpagide 	*V. agnus-castus*	Leaves/EtOH extract		(Ramazanov, 2004)
26	8-*O*-Acetylharpagide 	*V. agnus-castus*	Leaves/EtOH extract		(Ramazanov, 2004)
27	2′-*O*-*p*-Hdroxybenzoyl-6′-*O*-*trans*-caffeoylgardoside 	*V. altissima*	Leaves/EtOAc extract	Potent antioxidant activity as measured using superoxide (NBT riboflavin photoreduction) free-radical-scavenging method with IC_{50} value 32.0 μM and DPPH-radical-scavenging method with IC_{50} value 10.9 μM.	(Sridhar et al., 2004)

TABLE 1 (Continued)

Compound No.	Compound name	Plant source	Plant part/extraction solvent/fraction	Biological activity	References
28	1,4a,5,7a-Tetrahydro-1-β-D-glucosyl-7-(3′,4′-dihydroxybenzoyloxymethyl)-5-ketocyclopenta[c]pyran-4-carboxylic acid 	*V. negundo*	Leaves/MeOH, petroleum ether extract		(Sharma, Prabhakar, Dhar, & Sachar, 2009)
29	Vitexnegheteroin K 	*V. negundo*	Leaves/ 95% EtOH/ EtOAc extract	Moderate inhibitory effects on α-glucosidase (IC_{50}, 1.30 ± 0.01 μM) and weaker antioxidant effects {DPPH assay (IC_{50}, 100>μM); ABTS assay (IC_{50}, 85.55 ± 5.52 μM)}	(Hu, Li, Jia, et al., 2017)
30	Vitexnegheteroin L 	*V. negundo*	Leaves/ 95% EtOH/ EtOAc extract	Moderate inhibitory effects on α-glucosidase (IC_{50}, 7.42 ± 0.03 μM) and weaker antioxidant effects {DPPH assay (IC_{50}, 100>μM); ABTS assay (IC_{50}, 67.13 ± 4.27 μM)}.	(Hu et al., 2017)
31	Eucommiol 	*V. rotandifolia*	Fruit/MeOH extract		(Ono et al., 1997)
32	Iridolactone 	*V. rotandifolia*	Fruit/MeOH extract		(Ono et al., 1997)
33	Pedicularis-lactone 	*V. rotandifolia*	Fruit/MeOH extract		(Ono et al., 1997)
34	1-*oxo*-Eucommiol 	*V. rotandifolia*	Fruit/MeOH extract		(Ono et al., 1997)

(Continues)

TABLE 1 (Continued)

Compound No.	Compound name	Plant source	Plant part/extraction solvent/fraction	Biological activity	References
35	(1*S*, 5*S*,6*R*,9*R*)-10-*O*-*p*-Hydroxybenzoyl-5,6β-dihydroxy iridoid 1-*O*-β-D-glucopyranoside 	*V. trifolia*	Fruit/80% EtOH extract, *n*-BuOH fraction	Inhibitory effects on nitric oxide (NO) production in LPS-induced RAW 264.7 macrophages with IC_{50} value of 90.05 μM.	(Bao, Tang, Cheng, et al., 2018)
36	Khainaoside B (7-*O*-*E*-Feruloyl-8-epiloganic acid) 	*V. glabrata*	Leaves/MeOH extract, H_2O fraction		(Luecha, Umehara, Miyase, & Noguchi, 2009)
37	Pinnatoside 	*V. pinnata*	Barks/EtOH extract, $CHCl_3$:MeOH (70:30) fraction	Antifungal activity against *Candida albicans* with a MIC of 16 μg/ml	(Ata, Mbong, Iverson, & Samarasekera, 2009)

via inhibition of p38, ERK1/2, and JNK pathway (Rosa, Rios-Santos, Balogun, & Martins, 2016).

5.1.2 | Antimicrobial activity

Compounds,4′,5,7-Trihydroxy-3′-*O*-β-D-glucuronic acid-6″-methyl ester (**263**) and negundoside (**15**) isolated from *V. negundo* leaves exhibited significant antifungal activity against *Trichophyton mentagrophytes* and *Cryptococous neoformans* with MIC value of 6.25 μg/ml. Flucanazole was used as a standard drug (Sathiamoorthy et al., 2007).

Supercritical fluid extract of *V. negundo* leaves exhibited strong antibacterial activity against *Bacillus subtilis* and *Staphylococcus aureus* and mild activity against *Escherichia coli*, *Pseudomonas aeruginosa* and yeast, *Candida albicans* in disc diffusion assay (Nagarsekar, Nagarsenker, & Kulkarni, 2010).

Vitex negundo leaf and bark methanolic extract, fresh leaf, as well as leaf aqueous extracts were shown to have significant antimicrobial activity against bacteria and fungal strains, for example, *Bacillus cereus*, *Staphylococcus aureus*, *Escherichia coli*, *Salmonella typhimurium*, *Shigella sonnei*, *Klebsiella pneumoniae*, *Shigella dysentriae*, *K. pneumonia*, *Vibrio cholera*, *Candida albicans*, *Candida tropicalis*, etc. (Devi, Kokilavani, & Poongothai, 2008) (Panda, Mohanta, Padhi, et al., 2016) (Prakash, Ramasubburayan, Ramkumar, et al., 2016).

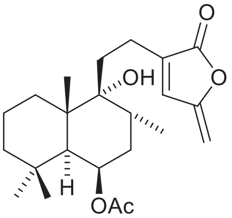
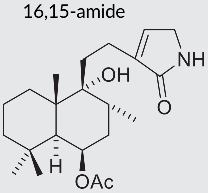
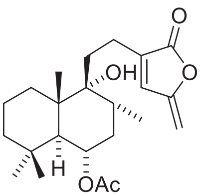
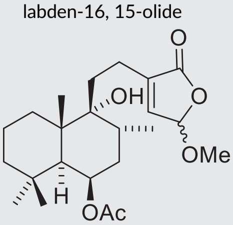
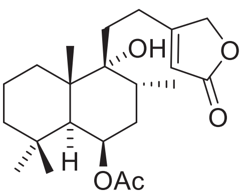
Ethanol crude extract of leaf of *V. doniana* displayed *in-vitro* antibacterial activity with minimum inhibitory concentration (MIC) value of 93.75 μg/ml against *S. aureus* and *B. subtilis* in a 96 well plate resazurin-based broth microdilution method with the antimicrobial drugs ampicillin and nystatin used as positive control (Abiodun, Sood, Osiyemi, et al., 2015).

The lignans, vitrofolals C (**362**), and D (**361**) and detetrahydroconidendrin (**353**) isolated from *V. rotundifolia* aerial parts showed significant antibacterial activity against various methicillin-resistant *S. aureus* (MRSA) strains with MIC values in the range of 4–64 μg/ml in broth dilution method (Kawazoe et al., 2001).

The essential oils obtained by hydrodistillation from the aerial parts of *V. rivularis* showed antifungal activity against yeasts and dermatophyte strains with MIC and minimum lethal concentration (MLC) values ranging from 0.16 to 0.64 μl/ml and 0.32 to 2.5 μl/ml, respectively (Cabral et al., 2009).

Vitelignin A (**377**) isolated from *V. negundo* seeds showed moderate antifungal activity against *C. albicans*, *Cryptococcus neoformans*, and *Trichophyton rubrum* with MIC values of 32, 64, and 32 μg/ml, respectively (Zheng et al., 2011).

TABLE 2 List of diterpenoids reported from different species of *Vitex* and their pharmacological activities

Compound No.	Compound name	Plant source	Plant parts/extraction solvent/fraction	Biological activity	References
38	(*rel* 5*S*, 6*R*, 8*R*, 9*R*, 10*S*)-6-Acetoxy-9-hydroxy-13(14)-labden-16,15-olide 	*V. rotundifolia*	Fruit/MeOH extract		(Ono, Yamamoto, Yanaka, et al., 2001)
		V. trifolia	Fruit/acetone		(Kiuchi, Matsuo, Ito, et al., 2004)
			Fruit/H_2O:acetone (7:3) extract	Exhibited inhibition of Hela cell proliferation in MTT assay with IC_{50} value in the range of 16.2 ± 0.9 μM.	(Wu, Zhou, Zhang, et al., 2009)
39	9αHydroxy-13(14)-labden-16,15-amide 	*V. agnus-castus*	Dried fruit/70% EtOH extract, $CHCl_3$ fraction	Cytotoxicity activity against chronic myelogenous leukemia (K562) cell lines with IC_{50} value of 0.70 μg/ml	(Pal, Li, Tewari, & Sun, 2013)
40	(*rel* 5*S*, 6*S*, 8*R*, 9*R*, 10*S*)-6-Acetoxy-9-hydroxy-13(14)-labden-16, 15-olide 	*V. rotundifolia*	Fruit/MeOH extract		(Ono, Yamamoto, et al., 2001)
41	(*rel* 5*S*, 6*R*, 8*R*, 9*R*, 10*S*)-6-Acetoxy-9-hydroxy-15-methoxy-13(14)-labden-16, 15-olide 	*V. rotundifolia*	Fruit/MeOH extract		(Ono, Yamamoto, et al., 2001)
42	Vitexilactone 	*V. rotundifolia*	Fruit/MeOH extract		(Ono, Yamamoto, et al., 2001) (Wang, Zhang, Zheng, et al., 2014)
			Fruit/MeOH extract		(Kim, Kim, Oh, & Seo, 2013)
			Plant/MeOH extract		(Kiuchi et al., 2004)
		V. trifolia	Fruit/acetone extract		(Zheng, Zhu, Yu, et al., 2013)
			Fruit/hot aq. EtOH	Cytotoxicity against four human cancer cell lines (A549, HCT116, HL-60, and ZR-75-30), but did not show any activity (IC_{50} < 5 μg/ml).	(J. Wu et al., 2009)
			Fruit/H_2O:acetone (7:3)	Exhibited inhibition of Hela cell proliferation in MTT assay with IC_{50} value in the range of 9.5 ± 0.8 μM.	(Ono, Eguchi, Konoshita, et al., 2011)

(Continues)

TABLE 2 (Continued)

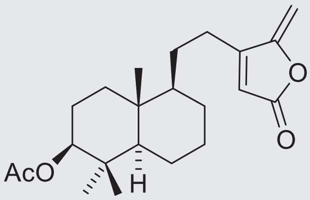
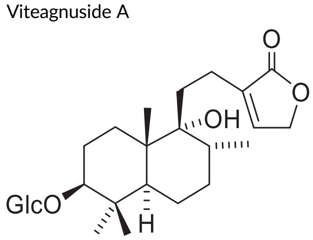
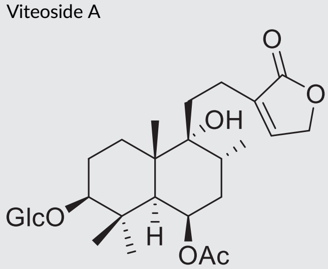
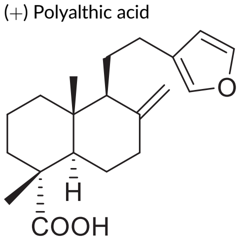
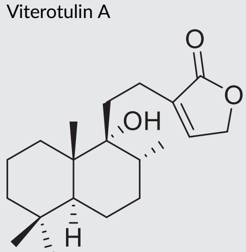
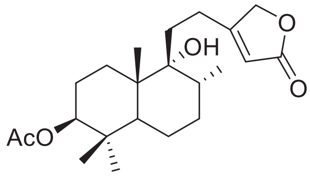
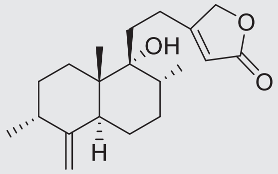
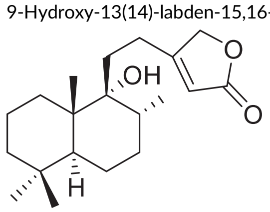
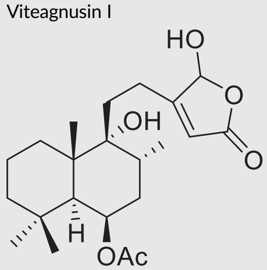
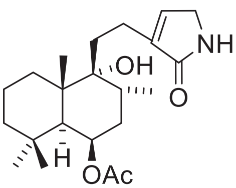
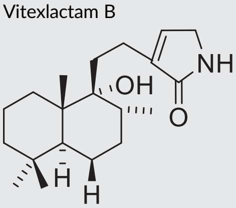
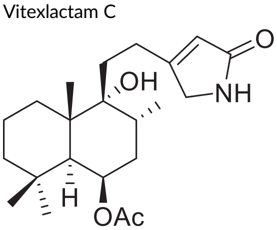
Compound No.	Compound name	Plant source	Plant parts/extraction solvent/fraction	Biological activity	References
		V. agnus-castus	Fruit/acetone extract		(Pal et al., 2013)
			Fruit/70% EtOH, $CHCl_3$ fraction	Cytotoxicity activity against chronic myelogenous leukemia (K562) cell lines with IC_{50} value of 2.73 μg/ml	(Hu et al., 2016)
		V. negundo	Seeds/95% EtOH extract		(Qiu et al., 2016)
			Leaves/70% EtOH extract		
43	Vitexilactone B 	*V. trifolia*	Fruit/hot aq. EtOH extract		(Zheng et al., 2013)
		V. negundo	Seeds/aq. EtOH extract		(Zheng, Huang, Wu, et al., 2010)
44	Viteagnuside A 	*V. agnus-castus*	Fruit/acetone extrac		(Ono et al., 2011)
		V. negundo	Leaves/70% EtOH		(Qiu et al., 2016)
45	Viteoside A 	*V. rotundifolia*	Fruit/MeOH extract		(Ono, Ito, & Nohara, 1998)
46	(+) Polyalthic acid 	*V. rotundiforia*	Plant/MeOH extract, DCM fraction		(Miyazawa, Shimamura, Nakamura, & Kameoka, 1995)
		V. negundo	Fruit/40% EtOH extract	Significant inhibitory effects against A-549 cell line with IC_{50} value 20.3 μM.	(Huang, Qing, Zeng, et al., 2013)
47	Viterotulin A 	*V. rotundifolia*	Fruit/MeOH extract, DCM fraction	Inhibitory activities on LPS-induced nitric oxide production in RAW264.7 cells with IC_{50} value 16.4 μM	(Lee, Lee, Jin, et al., 2013)

TABLE 2 (Continued)

Compound No.	Compound name	Plant source	Plant parts/extraction solvent/fraction	Biological activity	References
48	Viterotulin B 	*V. rotundifolia*	Fruit/MeOH extract, DCM fraction	Inhibitory effects on LPS-induced nitric oxide production in RAW264.7 cells with IC_{50} value 49.1 μM	(Lee et al., 2013)
49	Vitexilactone C 	*V. negundu*	Aerial part/EtOH		(Chen, Li, Ling, et al., 2012)
			seeds/95% EtOH extract	Inhibitory effect on nitric oxide (NO) production in murine microglial BV-2 cell line by the Griess reaction with IC_{50} value 10.79 ± 1.16 μM.	(Hu et al., 2016)
50	9-Hydroxy-13(14)-labden-15,16-olide 	*V. trifolia*	Leaves/MeOH, hexane fraction	Antitubercular activity (MIC = 100 μg/ml) against *Mycobacterium tuberculosis* H37Rv in BACTEC-460 assay	(Tiwari, Thakur, et al., 2013)
51	Viteagnusin I 	*V. agnus-castus*	Fruit/MeOH extract		(Chen, Friesen, Webster, et al., 2011)
		V. trifolia	Fruit/hot aq. EtOH (80%) extract, DCM fraction	Cytotoxicity against four human cancer cell lines (A549, HCT116, HL-60, and ZR-75-30), but did not show any activity (IC_{50} < 5 μg/ml)	(Zheng et al., 2013)
52	Vitexlactam A 	*V. agnus-castus*	Fruit/*n*-hexane extract		(Li, Zhang, Qiu, et al., 2002)
			Fruit/*n*-hexane extract		(Li et al., 2013)
		V. rotundifolia	Fruit/MeOH, $CHCl_3$ fraction		(Wang et al., 2014)
53	Vitexlactam B 	*V. agnus-castus*	fruit/*n*-hexane extract		(Li et al., 2013)
54	Vitexlactam C 	*V. agnus-castus*	Fruit/*n*-hexane extract	Induced flavoenzyme NADP(H):quinine oxidoreductase type 1 (QR1), toxic to Hepa 1c1c7 cells.	(Li et al., 2013)

(Continues)

TABLE 2 (Continued)

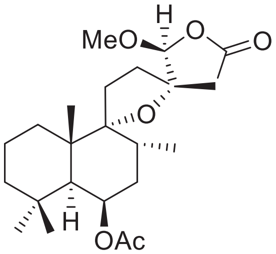
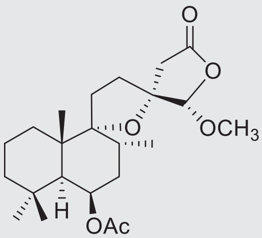
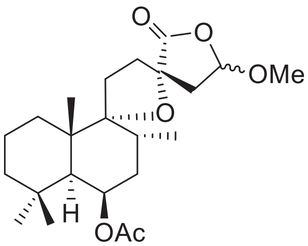
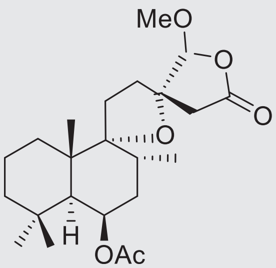
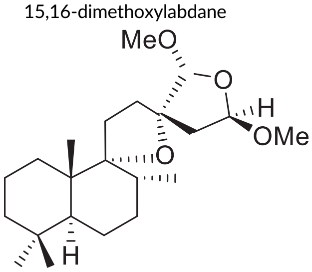
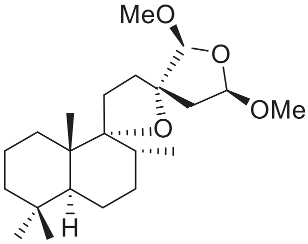
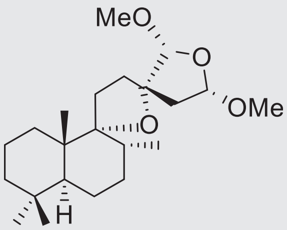
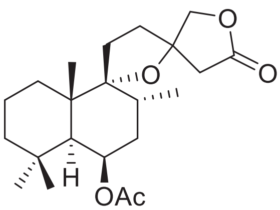
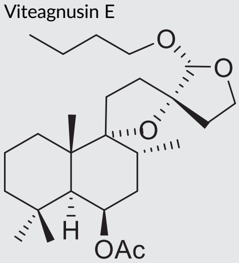
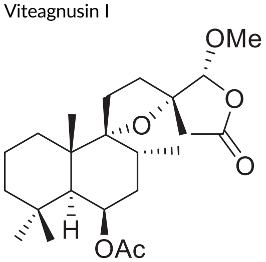
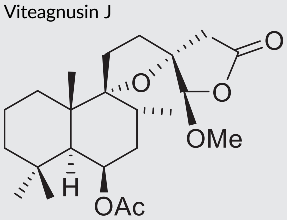
Compound No.	Compound name	Plant source	Plant parts/extraction solvent/fraction	Biological activity	References
55	(*rel* 5*S*,6*R*,8*R*,9*R*,10*S*,13*S*,16*S*)-6-Acetoxy-9,13-epoxy-16-methoxy labdan-15,16-olide 	*V. rotundifoli*	Fruit/MeOH extract		(Ono, Yamamoto, et al., 2001)
		V. agnus-castus	Fruit/acetone extract		(Ono et al., 2011)
56	(*rel* 5*S*,6*R*,8*R*,9*R*,10*S*,13*R*,16*S*)-6-Acetoxy-9,13-epoxy-16-methoxy labdan-15,16-olide 	*V. rotundifolia*	Fruit/MeOH extract		(Ono, Yamamoto, et al., 2001)
		V. agnus-castus	Fruit/acetone extract		(Ono et al., 2011)
57	(*rel* 5*S*,6*R*,8*R*,9*R*,10*S*,13*S*)-6-Acetoxy-9,13-epoxy-15-methoxy labdan-16,15-olide 	*V. rotundifolia*	Fruit/MeOH extract		(Ono, Yamamoto, et al., 2001)
		V. agnus-castus	Fruit/acetone extract		(Ono et al., 2011)
58	(*rel* 5*S*,6*R*, 8*R*, 9*R*, 10*S*, 13*R*)-6-Acetoxy-9,13-epoxy-15-methoxy labdan-16, 15-olide 	*V. rotundifolia*	Fruit/MeOH extract		(Ono, Yamamoto, et al., 2001)
		V. agnus-castus	Fruit/acetone extract		(Ono et al., 2011)
			Fruit/hexane extract		(Ono, Yamasaki, Konoshita, et al., 2008)
59	(*rel* 5*S*,8*R*,9*R*,10*S*,13*S*,15*S*,16*R*)-9,13;15,16-Diepoxy-15,16-dimethoxylabdane 	*V. rotundifolia*	Fruit/MeOH extract		(Ono, Yamamoto, et al., 2001)

TABLE 2 (Continued)

Compound No.	Compound name	Plant source	Plant parts/extraction solvent/fraction	Biological activity	References
60	(*rel 5S,8R,9R,10S,13S,15R,16S*)-9, 13; 15, 16-Diepoxy-15, 16-dimethoxylabdane 	*V. rotundifolia*	Fruit/MeOH extract		(Ono, Yamamoto, et al., 2001)
61	(*rel 5S,8R,9R,10S,13S,15R,16R*)-9,13;15,16-Diepoxy-15, 16-dimethoxylabdane 	*V. rotundifolia*	Fruit/MeOH extract		(Ono, Yamamoto, et al., 2001)
62	Previtexilactone 	*V. trifolia*	Fruit/acetone extract		(Kiuchi et al., 2004)
			Fruit/H_2O:acetone (7:3) extract	Exhibited inhibition of Hela cell proliferation in MTT assay with IC_{50} value in the range of 19.4 ± 1.4 μM	(Wu et al., 2009)
			Fruit/hot 80% EtOH extract, DCM fraction		(Zheng et al., 2013)
63	Viteagnusin E 	*V. agnus-castus*	Fruit/hexane extract		(Ono et al., 2008)
64	Viteagnusin I 	*V. agnus-castus*	Fruit/acetone extract		(Ono et al., 2011)
65	Viteagnusin J 	*V. agnus-castus*	Fruit/acetone extract		(Ono et al., 2011)

(Continues)

TABLE 2 (Continued)

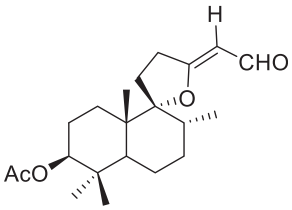
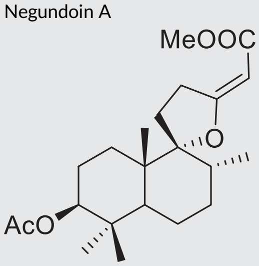
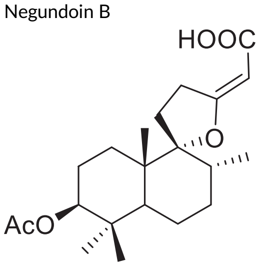
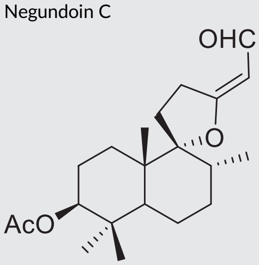
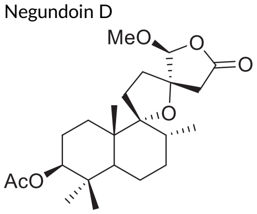
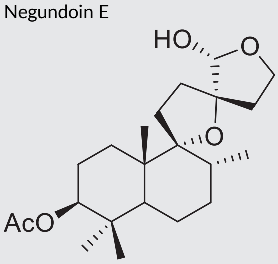
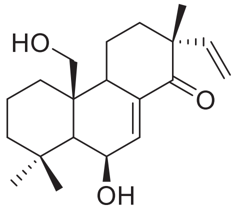
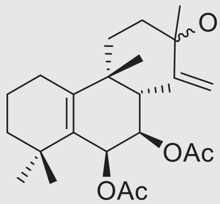
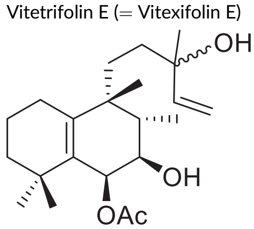
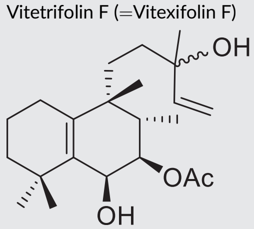
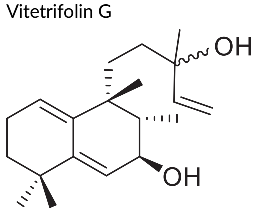
Compound No.	Compound name	Plant source	Plant parts/extraction solvent/fraction	Biological activity	References
66	Negundoal 	*V. negundo*	Seeds/aq. EtOH 80% extract	Cytotoxicity against human lung carcinoma (A549) cell line having IC_{50} value >100 μg/ml; colon carcinoma (HCT116) cell line having IC_{50} value 24.59±2.24 μg/ml; blood cancer (HL-60) cell line having IC_{50} value 11.23±1.01 μg/ml; and breast carcinoma (ZR-75-30) cell line having IC_{50} 20.04± 3.15 μg/ml	(Zheng, Pu, Zhang, et al., 2012)
67	Negundoin A 	*V. negundo*	Seeds/EtOH 80% extract, DCM fraction	NO production inhibitory in LPS-stimulated RAW 264.7 cells with IC_{50} value of 9.83 μM.	(Zheng, Huang, Wang, et al., 2010)
68	Negundoin B 	*V. negundo*	Seeds/EtOH 80% extract, DCM fraction	NO production inhibitory in LPS-stimulated RAW 264.7 cells with IC_{50} value of 23.43 μM.	(Zheng, Huang, Wang, et al., 2010)
69	Negundoin C 	*V. negundo*	Fruits/MeOH extract, EtOAc fraction,	NO production inhibitory in LPS-stimulated RAW 264.7 cells with IC_{50} value of 0.12 μM.	(Zheng, Huang, Wang, et al., 2010)
			Seeds/DCM fraction		(Fang, Kong, & Yan, 2016b)
		V. trifolia	Leaves/95% EtOH extract, EtOAc fraction		(Luo, Yu, Liu, et al., 2017)
70	Negundoin D 	*V. negundo*	Seeds/EtOH 80% extract, DCM fraction	NO production inhibitory in LPS-stimulated RAW 264.7 cells with IC_{50} value of 4.39 μM.	(Zheng, Huang, Wang, et al., 2010)
			Leaves/70% EtOH extract		(Qiu et al., 2016)
71	Negundoin E 	*V. negundo*	Seeds/EtOH 80% extract, DCM fraction	NO production inhibitory in LPS-stimulated RAW 264.7 cells with IC_{50} value of 0.23 μM.	(Zheng, Huang, Wang, et al., 2010)

TABLE 2 (Continued)

Compound No.	Compound name	Plant source	Plant parts/extraction solvent/fraction	Biological activity	References
72	Negundoin G 	*V. negundo*	Seeds/EtOH 80% extract, DCM fraction	NO production inhibitory in LPS-stimulated RAW 264.7 cells with IC_{50} value of 0.30 μM.	(Zheng, Huang, Wang, et al., 2010)
			Seeds/95% EtOH extract, DCM fraction	NO production inhibitory in LPS-stimulated RAW 264.7 cells with IC_{50} value of 0.71±0.16 μM.	(Hu et al., 2016)
73	Vitetrifolin D 	*V. trifolia*	Fruit/acetone extract		(Ono, Ito, & Nohara, 2001)
			Fruit/H_2O:acetone (7:3) extract	Exhibited inhibition of Hela cell proliferation in MTT assay with IC_{50} value in the range of 15.0 ± 1.7 μM	(Wu et al., 2009)
			Leaves/95% EtOH extract, EtOAc fraction		(Luo et al., 2017)
		V. rotundifolia	Whole plant/DCM/MeOH		(Kim et al., 2013)
			Fruit/MeOH extract		(Ono, Yanaka, Yamamoto, et al., 2002)
		V. agnus-castus	Fruit/acetone extract		(Ono et al., 2011)
			Fruit/70% EtOH extract, $CHCl_3$ fraction	Cytotoxicity activity against chronic myelogenous leukemia (K562) cell lines with IC_{50} value 6.72 μg/ml	(Pal et al., 2013)
		V. negundo.	Whole plant/MeOH extract, EtOAc fraction	Exhibited cytotoxicity against cancer cell lines and Hedgehog (Hh) signaling pathway inhibitor.	(Arai et al., 2013)
			Seeds/Aq. EtOH extract		(Zheng, Lan, Bin, et al., 2011)
74	Vitetrifolin E (= Vitexifolin E) 	*V. trifolia*	Fruit/acetone extract		(Ono, Ito, & Nohara, 2001)
			Fruit/H_2O:acetone (7:3) extract		(Wu et al., 2009)
		V. rotundifolia	Whole plant/MeOH extract, DCM fraction		(Kim et al., 2013)
75	Vitetrifolin F (=Vitexifolin F) 	*V. trifolia*	Fruit/acetone extract		(Ono, Ito, & Nohara, 2001)
			Fruit/H_2O:acetone (7:3)		(Wu et al., 2009)
		V. rotundifolia	Whole plant/MeOH extract, DCM fraction		(Kim et al., 2013)
76	Vitetrifolin G 	*V. trifolia*	Fruit/acetone extract		(Ono, Ito, & Nohara, 2001)

(Continues)

TABLE 2 (Continued)

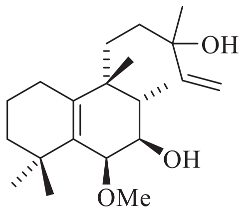
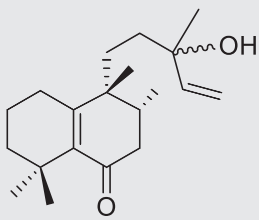
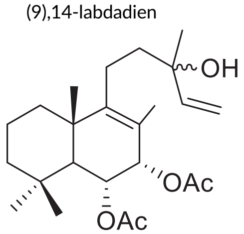
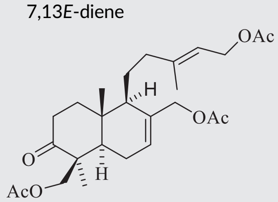
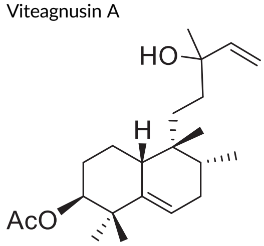
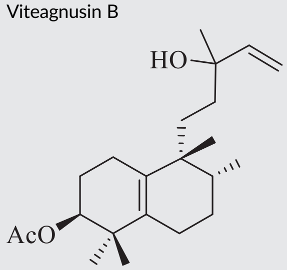
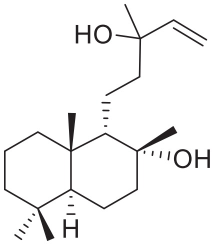
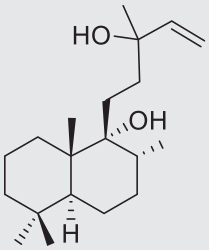
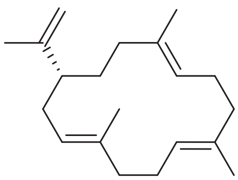
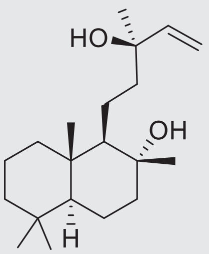
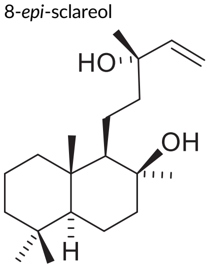
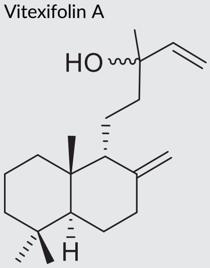
Compound No.	Compound name	Plant source	Plant parts/extraction solvent/fraction	Biological activity	References
77	Vitetrifolin H 	*V. rotundifolia*	Fruit/MeOH extract, DCM soluble fraction	NO production inhibitory in LPS-stimulated RAW 264.7 cells with IC_{50} value of 22.2 μM.	(Lee et al., 2013)
		V. trifolia	Fruit/H_2O:acetone (7:3)/$CHCl_3$ extract	Exhibited inhibition of Hela cell proliferation in MTT assay with IC_{50} value in the range of 15.1 ± 0.9 μM.	(Wu et al., 2009)
		V. trifolia	Fruit/ hot 80% EtOH extract/DCM fraction	Cytotoxicity against a small panel of cancer cell line (A549, HCT116, HL-60, and ZR-75-30).	(Zheng et al., 2013)
78	13-Hydroxy-5 (10),14-halimadien-6-one 	*V. trifolia*	Leaves/MeOH, hexane fraction		(Tiwari, Thakur, et al., 2013)
79	6*α*,7*α*-diacetoxy-13-hydroxy-8 (9),14-labdadien 	*V. trifolia*	Leaves/MeOH, Hexane fraction		(Tiwari, Thakur, et al., 2013)
80	3-*oxo*-15,17,18-Triacetoxy labda-7,13*E*-diene 	*V. cauliflora*	Aerial Parts/EtOH		(Rasamison, Ranaivo-Harimanana, Cao, et al., 2010)
81	Viteagnusin A 	*V. agnus-castus*	Fruit/hexane extract		(Ono et al., 2008)
82	Viteagnusin B 	*V. agnus-castus*	Fruit/hexane extract		(Ono et al., 2008)

TABLE 2 (Continued)

Compound No.	Compound name	Plant source	Plant parts/extraction solvent/fraction	Biological activity	References
83	Viteagnusin C 	*V. agnus-castus*	Fruit/hexane extract		(Ono et al., 2008))
		V. negundo	Seeds/80% aq. EtOH		(Zheng, Huang, Wang, et al., 2010)
84	Viteagnusin D 	*V. agnus-castus*	Fruit/Hexane extract		(Ono et al., 2008)
85	Cembrene 	*V. agnus-castus*	Seed/essential oil		(Asdadi, Hamdouch, Oukacha, et al., 2015)
86	Sclareol 	*V. agnus-castus*	Seed/essential oil		(Asdadi et al., 2015)
87	8-*epi*-sclareol 	*V. agnus-castus*	Fruit/hexane		(Ono et al., 2011)
		V. negundo	Whole plant/MeOH	Hedgehog (Hh) signaling pathway inhibitor.	(Arai et al., 2013)
		V. negundo	Seeds/80% Aq. EtOH		(Zheng, Huang, Wang, et al., 2010)
88	Vitexifolin A 	*V. rotundifolia*	Fruit/MeOH extract		(Ono et al., 2002)

(Continues)

TABLE 2 (Continued)

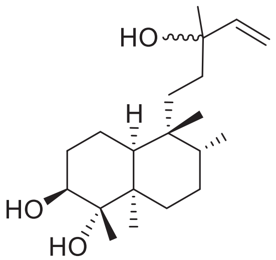
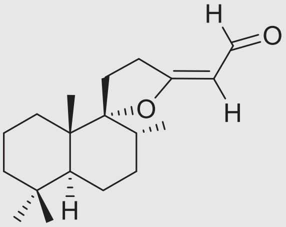
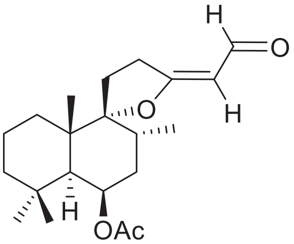
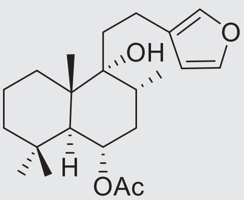
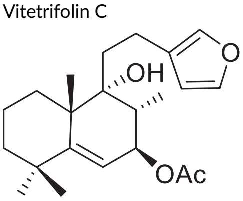
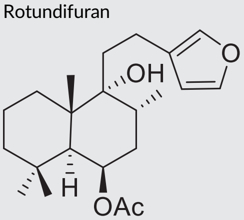
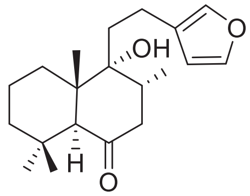
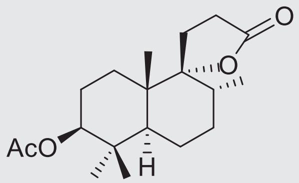
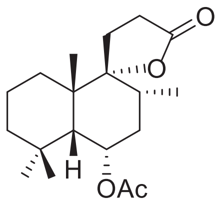
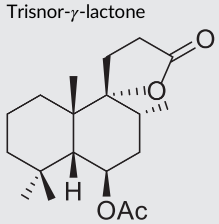
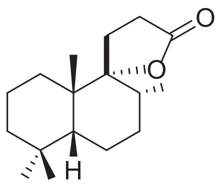
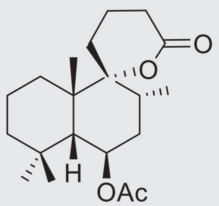
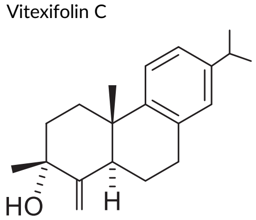
Compound No.	Compound name	Plant source	Plant parts/extraction solvent/fraction	Biological activity	References
89	Vitexifolin B 	*V. rotundifolia*	Fruit/MeOH extract		(Ono et al., 2002)
90	Norditerpene aldehyde 1 	*V. trifolia*	Fruit/acetone extract	*In-vitro* minimum lethal concentration against epimastigotes of *Trypanosoma cruzi* 11μM.	(Kiuchi et al., 2004)
91	Norditerpene aldehyde 2 	*V. trifolia*	Fruit/Acetone extract	*In-vitro* minimum lethal concentration against epimastigotes of *Trypanosoma cruzi* 36 μM.	(Kiuchi et al., 2004)
92	Vitetrifolin B 	*V. trifolia*	Fruit/acetone extract		(Ono, Sawamura, Ito, et al., 2000)
93	Vitetrifolin C 	*V. trifolia*	Fruit/acetone extract		(Ono et al., 2000)
94	Rotundifuran 	*V. rotundifolia*	Leaves/light petroleum extract		(Asaka, Kamikawa, & Kubota, 1973)
		V. trifolia	Fruit/acetone extract		(Ono et al., 2000)
		V. trifolia	Fruit/hot 80% EtOH extract/DCM fraction		(Zheng et al., 2013)
		V. agnus-castus	Seeds/70% EtOH extract		(Jarry, Spengler, Wuttke, & Christoffel, 2006)
			Fruit/80% MeOH extract	Affinity to the dopamine-D_2-receptor	(Hoberg, Orjala, Meier, & Sticher, 1999)
			Fruit/70% EtOH extract, $CHCl_3$ fraction	Cytotoxicity activity against chronic myelogenous leukemia (K562) cell lines with IC_{50} value 2.91 μg/ml	(Pal et al., 2013)

TABLE 2 (Continued)

Compound No.	Compound name	Plant source	Plant parts/extraction solvent/fraction	Biological activity	References
95	Dihydrosolidagenone 	*V. trifolia*	Fruit/acetone extract		(Ono et al., 2000)
96	Vitedoin B 	*V. negundo*	Seeds/DCM extract Seeds/MeOH extract		(Zheng, Huang, Wang, et al., 2010) (Ono, Nishida, Masuoka, et al., 2004)
97	Vitexifolin D 	*V. rotundifolia*	Fruit/MeOH extract		(Ono et al., 2002)
98	Trisnor-γ-lactone 	*V. rotundifolia*	Fruit/MeOH extract		(Ono et al., 2002)
99	*iso*-Ambreinolide 	*V. rotundifolia*	Fruit/MeOH extract		(Ono et al., 2002)
100	Vitexifolin E 	*V. rotundifolia*	Fruit/MeOH extract		(Ono et al., 2002)
101	Vitexifolin C 	*V. rotundifolia*	Fruit/MeOH extract		(Ono et al., 2002)

(Continues)

TABLE 2 (Continued)

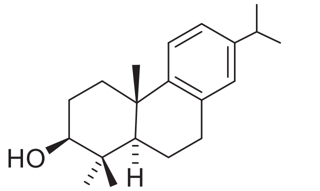
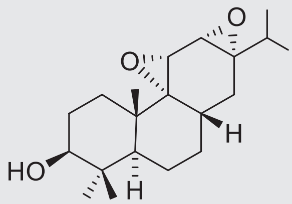
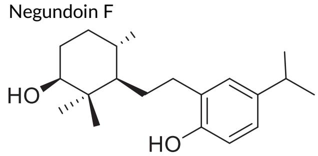
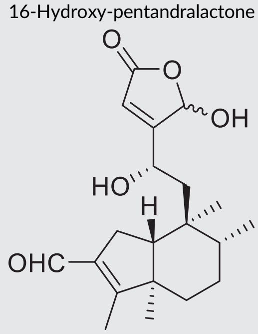
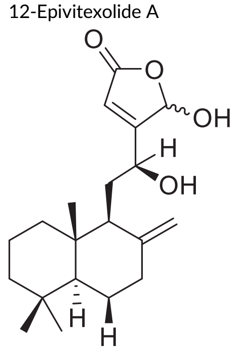
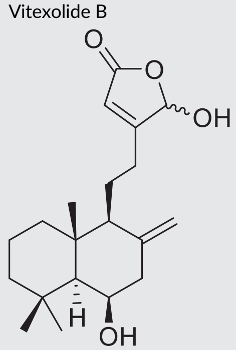
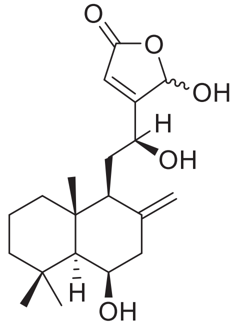
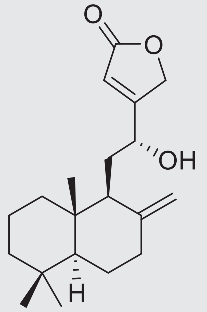
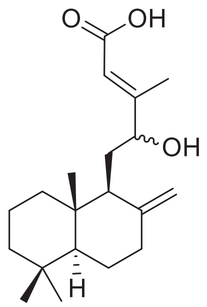
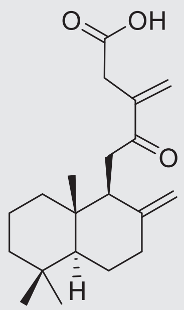
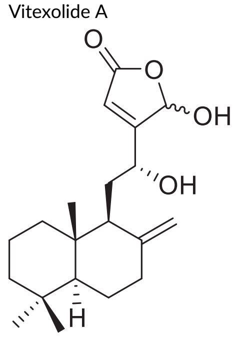
Compound No.	Compound name	Plant source	Plant parts/extraction solvent/fraction	Biological activity	References
102	Abietatrien-3β-ol 	*V. trifolia* *V. rotundifolia*	Fruit/acetone extract Fruit/MeOH extract		(Ono et al., 2000) Ono, Yamamoto, Masuoka, et al. (1999)
103	Vitetrifolin A 	*V. trifolia*	Fruit/acetone extract		(Ono et al., 2000)
104	Negundoin F 	*V. negundo*	Seeds/80% EtOH extract, DCM fraction	NO production inhibitory in LPS-stimulated RAW 264.7 cells with IC_{50} value of 1.16 μM.	(Zheng, Huang, Wang, et al., 2010)
105	16-Hydroxy-pentandralactone 	*V. cofassus*	Leaves/MeOH extract	Potent antiproliferative activity against five human tumor cell lines, namely lung carcinoma (A549), epidermoid carcinoma (KB), vincristine-resistant KB subline (KB-VIN), triple-negative breast cancer (MDA-MB-231), and estrogen receptor-positive breast cancer (MCF-7) with IC_{50} values ranged from 6.4 to 11.4 μM.	(Rasyid, Fukuyoshi, Ando, et al., 2017)
106	12-Epivitexolide A 	*V. vestita*	Leaves/DCM extract	Cytotoxic activities against human colon cancer carcinoma HCT-116 cell line (1 < IC_{50}s < 10 μM) and on a human fetal lung fibroblast MRC5 cell line (1 < IC_{50}s < 10 μM).	(Corlay, Lecsö-Bornet, Leborgne, et al., 2015)
107	Vitexolide B 	*V. vestita*	Leaves/DCM extract	Cytotoxic activity against human colon cancer carcinoma HCT-116 cell line (1 < IC_{50}s < 10 μM).	(Corlay et al., 2015)

TABLE 2 (Continued)

Compound No.	Compound name	Plant source	Plant parts/extraction solvent/fraction	Biological activity	References
108	Vitexolide C 	*V. vestita*	Leaves/DCM extract	Cytotoxic activity against human colon cancer carcinoma HCT-116 cell line (1 < IC_{50}s < 10 μM).	(Corlay et al., 2015)
109	Vitexolide E 	*V. vestita*	Leaves/DCM extract	Cytotoxic activities against human colon cancer carcinoma HCT-116 cell line (1 < IC_{50}s < 10 μM) and on a human fetal lung fibroblast MRC5 cell line (1 < IC_{50}s < 10 μM).	(Corlay et al., 2015)
110	Vitexolin A 	*V. vestita*	Leaves/DCM extract		(Corlay et al., 2015)
111	Vitexolin B 	*V. vestita*	Leaves/DCM extract	Cytotoxic activity against human colon cancer carcinoma HCT-116 cell line (1 < IC_{50}s < 10 μM).	(Corlay et al., 2015)
112	Vitexolide A 	*V. vestita*	Leaves/DCM extract	Potent antibacterial activity with MIC ranging from 6 to 96 μM and also cytotoxic activities against human colon cancer carcinoma HCT-116 cell line (1 < IC_{50}s < 10 μM) and on a human fetal lung fibroblast MRC5 cell line (1 < IC_{50}s < 10 μM).	(Corlay et al., 2015)

(Continues)

TABLE 2 (Continued)

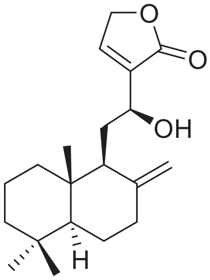
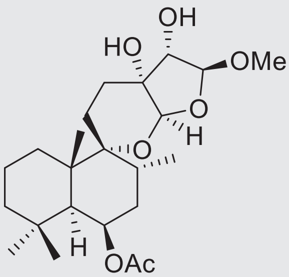
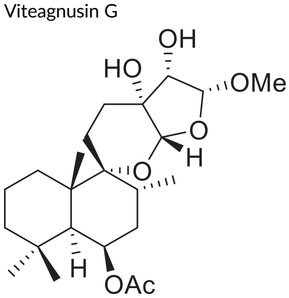
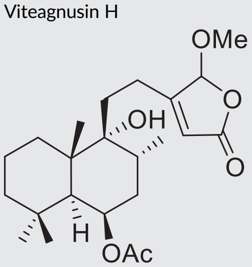
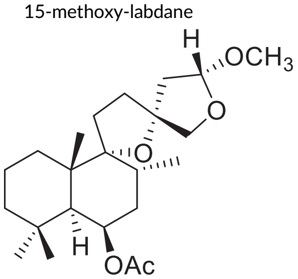
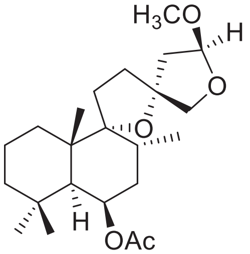
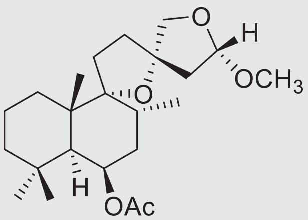
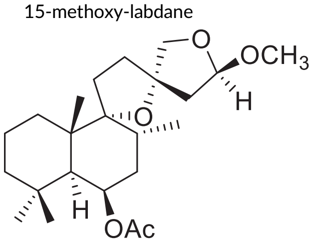
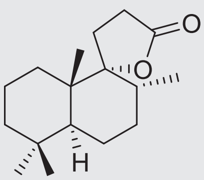
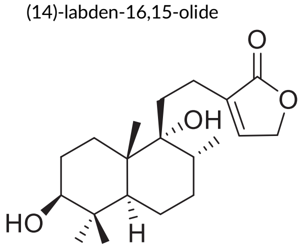
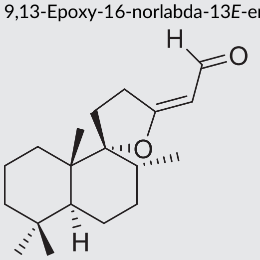
Compound No.	Compound name	Plant source	Plant parts/extraction solvent/fraction	Biological activity	References
113	Vitexolide D 	*V. vestita*	Leaves/DCM extract	Cytotoxic activities against human colon cancer carcinoma HCT-116 cell line (1 < IC_{50}s < 10 μM) and on a human fetal lung fibroblast MRC5 cell line (1 < IC_{50}s < 10 μM).	(Corlay et al., 2015)
114	Viteagnusin F 	*V. agnus-castus*	Fruit/hexane extract		(Ono, Nagasawa, Ikeda, et al., 2009)
115	Viteagnusin G 	*V. agnus-castus*	Fruit/hexane extract		(Ono et al., 2009)
116	Viteagnusin H 	*V. agnus-castus*	Fruit/hexane extract		(Ono et al., 2009)
117	(*rel* 5*S*,6*R*,8*R*,9*R*,10*S*,13*R*,15*R*)-6-Acetoxy-9,13,15,16-diepoxy-15-methoxy-labdane 	*V. agnus-castus*	Fruit/hexane extract		(Ono et al., 2009)

TABLE 2 (Continued)

Compound No.	Compound name	Plant source	Plant parts/extraction solvent/fraction	Biological activity	References
118	(*rel* 5*S*,6*R*,8*R*,9*R*,10*S*,13*R*,15*S*)-6-Acetoxy-9,13,15,16-diepoxy-15-methoxy-labdane 	*V. agnus-castus* *V. rotundifolia*	Fruit/hexane extract Fruit/MeOH extract		(Ono et al., 2009) (Ono et al., 1999)
119	(*rel* 5*S*,6*R*,8*R*,9*R*,10*S*,13*S*,15*S*)-6-Acetoxy-9,13,15,16-diepoxy-15-methoxy-labdane 	*V. agnus-castus* *V. rotundifolia*	Fruit/hexane extract Fruit/MeOH extract		(Ono et al., 2009) (Ono et al., 1999)
120	(*rel* 5*S*,6*R*,8*R*,9*R*,10*S*,13*S*,15*R*)-6-Acetoxy-9,13,15,16-diepoxy-15-methoxy-labdane 	*V. agnus-castus* *V. rotundifolia*	Fruit/hexane part Fruit/MeOH extract		(Ono et al., 2009) (Ono et al., 1999)
121	*Iso*-ambreinolide 	*V. agnus-castus*	Fruit/hexane part		(Ono et al., 2009)
122	(*rel* 3*S*,5*S*,8*R*,9*R*,10*S*)-3,9-dihydroxy-13(14)-labden-16,15-olide 	*V. rotundifolia*	Fruit/MeOH extract, DCM soluble fraction		(Lee et al., 2013)
123	9,13-Epoxy-16-norlabda-13*E*-en-15-al 	*V. rotundifolia*	Fruit/MeOH extract, DCM soluble fraction	NO production inhibitory in LPS-stimulated RAW 264.7 cells with IC_{50} value of 41.8 μM.	(Lee et al., 2013)

(Continues)

TABLE 2 (Continued)

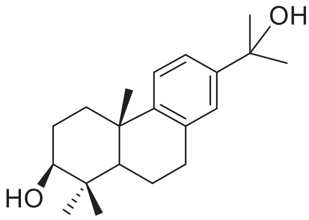
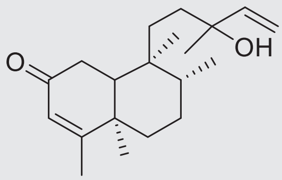
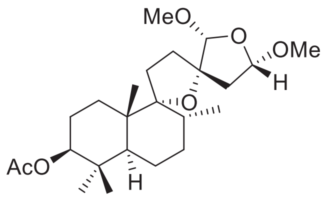
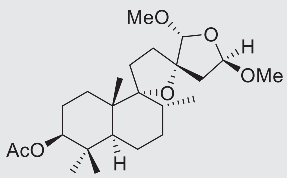
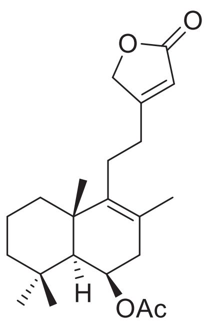
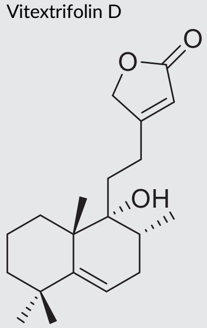
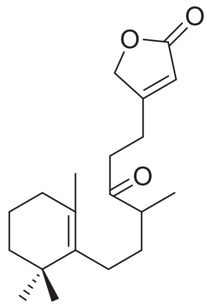
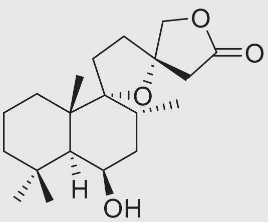
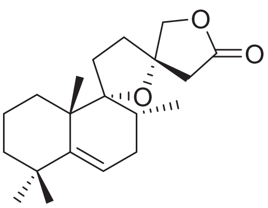
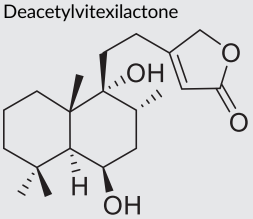
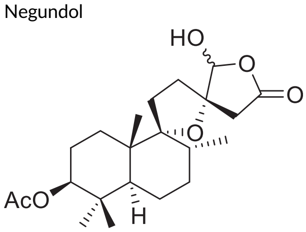
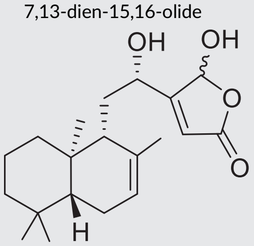
Compound No.	Compound name	Plant source	Plant parts/extraction solvent/fraction	Biological activity	References
124	Isolophanthin A 	*V. rotundifolia*	Fruit/MeOH extract, DCM soluble fraction		(Lee et al., 2013)
125	13-*epi*-2-Oxokolavelool 	*V. rotundifolia*	Fruit/MeOH extract, DCM soluble fraction		(Lee et al., 2013)
126	Vitextrifolin A 	*V. trifolia*	Fruit/hot aq. EtOH (80%) extract, DCM fraction		(Zheng et al., 2013)
127	Vitextrifolin B 	*V. trifolia*	Fruit/hot aq. EtOH (80%) extract, DCM fraction		(Zheng et al., 2013)
128	Vitextrifolin C 	*V. trifolia*	Fruit/hot aq. EtOH (80%) extract, DCM fraction		(Zheng et al., 2013)
129	Vitextrifolin D 	*V. trifolia*	Fruit/hot aq. EtOH (80%) extract, DCM fraction		(Zheng et al., 2013)

TABLE 2 (Continued)

Compound No.	Compound name	Plant source	Plant parts/extraction solvent/fraction	Biological activity	References
130	Vitextrifolin E 	*V. trifolia*	Fruit/hot aq. EtOH (80%) extract, DCM fraction		(Zheng et al., 2013)
131	Vitextrifolin F 	*V. trifolia*	Fruit/hot aq. EtOH (80%) extract, DCM fraction		(Zheng et al., 2013)
132	Vitextrifolin G 	*V. trifolia*	Fruit/hot aq. EtOH (80%) extract, DCM fraction		(Zheng et al., 2013)
133	Deacetylvitexilactone 	*V. trifolia*	Fruit/hot aq. EtOH (80%) extract, DCM fraction		(Zheng et al., 2013)
134	Negundol 	*V. trifolia*	Fruit/hot aq. EtOH (80%) extract, DCM fraction		(Zheng et al., 2013)
		V. negundo.	Fruits/80% EtOH extract	Antifungal activity with MIC_{80} values in the range of 16–64 μg/ml	(Zheng, Lan, Wang, et al., 2012)
			Fruit/EtOAc fraction of the MeOH extract		(Fang et al. 2016b)
135	12*S*,16*S*/*R*-Dihydroxy-ent-labda-7,13-dien-15,16-olide 	*V. rahmannii*	Aerial part/MeOH	Antioxidant, antimicrobial and cytotoxicity activity.	(Nyiligira, Viljoen, Van Heerden, et al., 2008)

(Continues)

TABLE 2 (Continued)

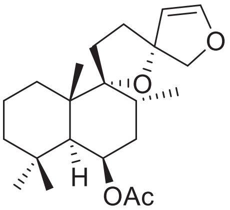
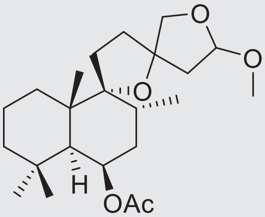
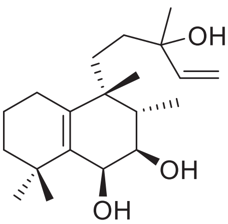
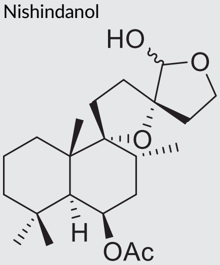
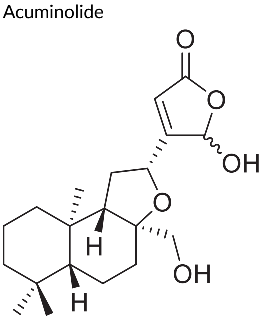
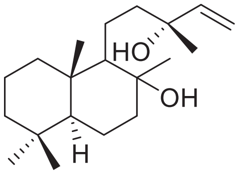
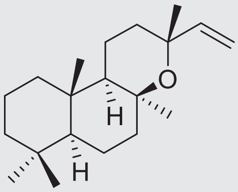
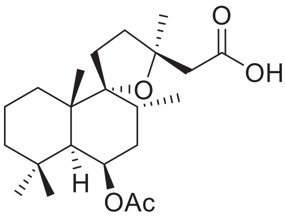
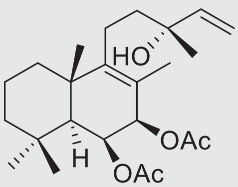
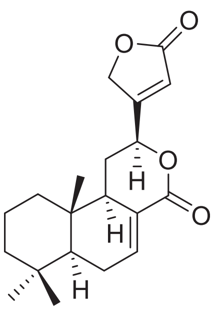
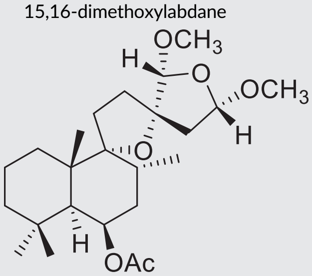
Compound No.	Compound name	Plant source	Plant parts/extraction solvent/fraction	Biological activity	References
136	Prerotundifuran 	*V. rotundifolia*	Seeds/Light petroleum extract		(Asaka et al., 1973)
137	6-Acetoxy-9,13;15,16-diepoxy-15-methoxylabdane 	*V. trifolia*	Fruits/H_2O: acetone -7:3(v/v), $CHCl_3$ extract	Inhibition of HeLa cell proliferation.	(Wu et al., 2009)
138	Vitetrifolin I 	*V. trifolia*	Fruits/H_2O: Acetone 7:3 (v/v), $CHCl_3$ extract	Cytotoxic activity, inhibition of HeLa cell proliferation, induced cell cycle G0/G1 phase arrest and apoptosis of HeLa cells.	(Wu et al., 2009)
139	Nishindanol 	*V. negundo*	Whole plant/MeOH extract, EtOAc fraction	Exhibited cytotoxicity against cancer cell lines and Hedgehog (Hh) signaling pathway inhibitor.	(Arai et al., 2013)
140	Acuminolide 	*V. vestita*	Leaves/DCM extract	Cytotoxicity against human colon cancer carcinoma HCT-116 cell line ($1 < IC_{50}s < 10$ μM) and on a human fetal lung fibroblast MRC5 cell line ($1 < IC_{50}s < 10$ μM).	(Corlay et al., 2015)
		V. cofassus	Leaves/MeOH extract	Potent antiproliferative activity against five human tumor cell lines, namely lung carcinoma (A549), epidermoid carcinoma (KB), vincristine-resistant KB subline (KB-VIN), triple-negative breast cancer (MDA-MB-231), and estrogen receptor-positive breast cancer (MCF-7) with IC_{50} values ranged from 5.4 to 8.9 μM.	(Rasyid et al., 2017)

TABLE 2 (Continued)

Compound No.	Compound name	Plant source	Plant parts/extraction solvent/fraction	Biological activity	References
141	8,13-Dihydroxy-14-labdene 	*V. agnus-castus*	Seeds/70% ethanol (v/v), hexane extract		(Jarry et al., 2006)
142	8-*epi*-Manoyl oxide 	*V. agnus-castus*	Fruit/*n*-hexane		(Li et al., 2013)
			Fruit/ 70% EtOH extract, $CHCl_3$ fraction	Weak cytotoxicity activity against chronic myelogenous leukemia (K562) cell lines with IC_{50} value of 4.56 μg/ml	(Pal et al., 2013)
			Fruit/defatted MeOH extract		(Chen et al., 2011)
143	Vitrifolin B 	*V. rotundifolia*	Fruit/MeOH extract/ $CHCl_3$ fraction		(Wang et al., 2014)
144	6*β*,7*β*-Diacetoxy-13-hydroxylabda-8,14-diene 	*V. agnus-castus*	Fruit/hexane 100%	Showed dopamine-D_2-receptor affinity.	(Hoberg et al., 1999)
			Vitex agnus-castus extract BNO 1095 [extract of finely ground seeds with aq. ethanol 70% (v/v)]-n hexane fraction	Affinity to the dopamine-D_2-receptor.	(Jarry et al., 2006)
145	Limonidilactone 	*V. limonifolia*	Leaves/*n*-hexane		(Aphaijitt, Nimgirawath, Suksamrarn, et al., 1995)
146	(rel 5*S*,6*R*,8*R*,9*R*,10*S*,13*S*,15*S*, 16*R*)-6-Acetoxy-9,13;15,16-diepoxy-15,16-dimethoxylabdane 	*V. rotundifolia*	Fruit/MeOH extract		(Ono et al., 1999)

(Continues)

TABLE 2 (Continued)

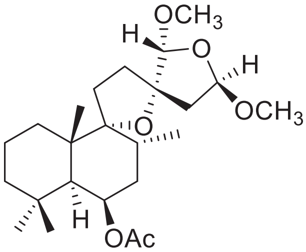
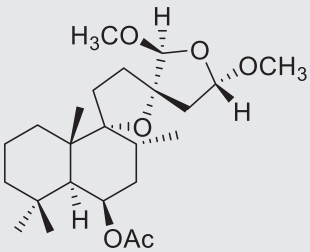
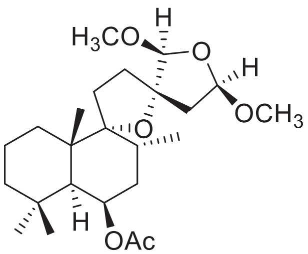
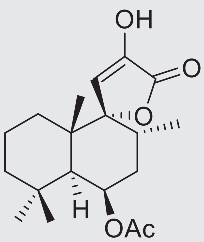
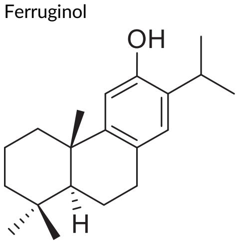
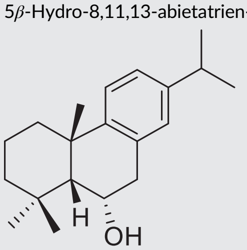
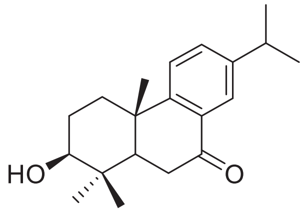
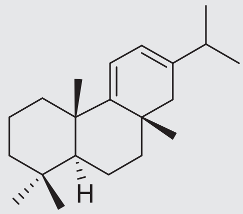
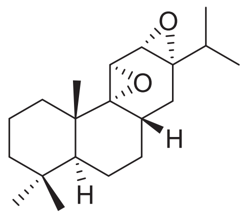
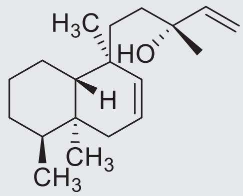
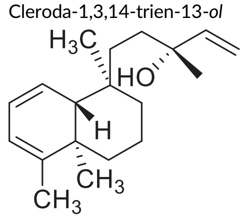
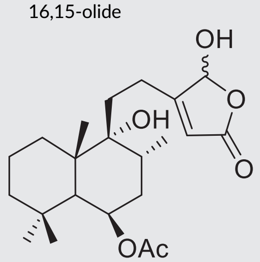
Compound No.	Compound name	Plant source	Plant parts/extraction solvent/fraction	Biological activity	References
147	(rel 5S,6R,8R,9R,10S,13S,15R, 16R)-6-Acetoxy-9,13,15,16-diepoxy-15,16-dimethoxylabdane 	*V. rotundifolia*	Fruit/MeOH extract	DPPH free radical scavenging activity.	(Ono et al., 1999)
148	(rel 5S, 6R, 8R, 9R, 10S, 13S, 15S, 16S)-6-Acetoxy-9,13,15,16-diepoxy-15,16-dimethoxylabdane 	*V. rotundifolia*	Fruit/MeOH extract		(Ono et al., 1999)
149	(rel 5S, 6R, 8R, 9R, 10S, 13S, 15R, 16S)-6-Acetoxy-9,13,15,16-diepoxy-15,16-dimethoxylabdane 	*V. rotundifolia*	Fruit/MeOH extract		(Ono et al., 1999)
150	Vitrifolin A 	*V. trifolia*	Fruit/MeOH extract	NO production inhibitory in LPS-stimulated RAW 264.7 cells with IC_{50} value of 22.3 μM.	(Zhang, Zhang, Xie, & Row, 2013)
151	Ferruginol 	*V. rotundifolia*	Fruit/MeOH extract	*In-vitro* strong DPPH radical scavenging activity.	(Ono et al., 1999)
152	5*β*-Hydro-8,11,13-abietatrien-6*α*-ol 	*V. negundo*	Seeds/$CHCl_3$ extract		(Chawla, Sharma, Handa, et al., 1991)

TABLE 2 (Continued)

Compound No.	Compound name	Plant source	Plant parts/extraction solvent/fraction	Biological activity	References
153	3*β*-Hydroxy-abieta-8,11,13-trien-7-one 	*V. negundo*	Seeds/DCM fraction		(Zheng, Huang, Wang, et al., 2010)
154	Abieta-9 (11), 12-diene 	*V. rotundifolia*	Fruit		(Sakurai, Okamoto, Kokubo, & Chida, 1999)
155	Abietane 9(11):12(13)-di-α-epoxide 	*V. rotundifolia*	Fruit		(Sakurai et al., 1999)
156	Cleroda-7,14-dien-13-ol 	*V. agnus-castus*	Seeds/70% ethanol (v/v), hexane extract	High dopaminergic activity.	(Jarry et al., 2006)
157	Cleroda-1,3,14-trien-13-*ol* 	*V. agnus-castus*	Seeds/70% ethanol (v/v), hexane extract	High dopaminergic activity.	(Jarry et al., 2006)
158	(5*S*,6*R*, 8*R*,9*R*,10*S*)-6-acetoxy-9, 16-dihydroxy-13,(14)-labden-16,15-olide 	*V. rotundifolia*	CH_2Cl_2 soluble fraction of MeOH extract of whole plant		(Kim et al., 2013)

(Continues)

TABLE 2 (Continued)

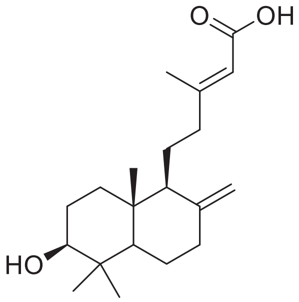
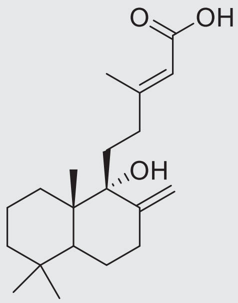
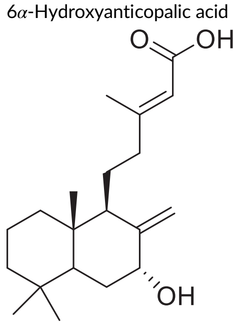
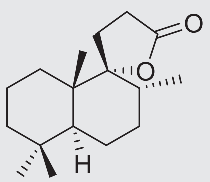
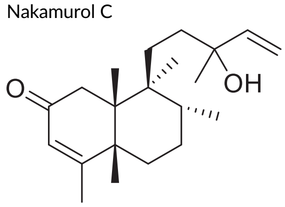
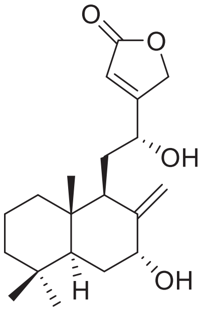
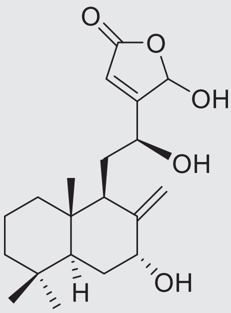
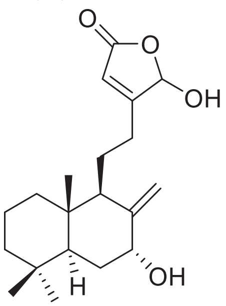
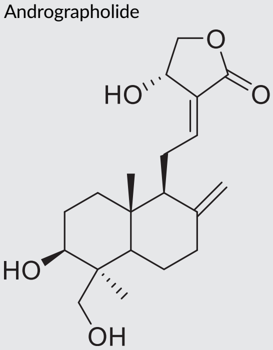
Compound No.	Compound name	Plant source	Plant parts/extraction solvent/fraction	Biological activity	References
159	3β- hydroxyanticopalic acid 	*V. vestita*	Leaves/DCM fraction		(Corlay et al., 2015)
160	8α-Hydroxyanticopalic acid 	*V. vestita*	Leaves/DCM fraction		(Corlay et al., 2015)
161	6α-Hydroxyanticopalic acid 	*V. vestita*	Leaves/DCM fraction		(Corlay et al., 2015)
162	Isoambreinolide 	*V. trifolia*	Leaves/MeOH extract/ hexane fraction	Antitubercular activity against *Mycobacterium tuberculosis* H37Rv in BACTEC-460 assay with MIC value 25 μg/ml	(Tiwari, Thakur, et al., 2013)
163	Nakamurol C 	*V. kwangsiensia*	Fruits/MeOH extract, $CHCl_3$ fraction		(Shen, Wang, Zhu, et al., 2019)

TABLE 2 (Continued)

Compound No.	Compound name	Plant source	Plant parts/extraction solvent/fraction	Biological activity	References
164	Vitexlimolide A (7α,12α-dihydroxylabda-8(17),13-dien-15,16-olide) 	*V. limonifolia*	Leaves/MeOH extract, DCM fraction		(Ban, Thoa, Linh, et al., 2017)
165	Vitexlimolide B (7α,12α,16-trihydroxylabda-8(17),13-dien-15,16-olide) 	*V. limonifolia*	Leaves/MeOH extract, DCM fraction		(Ban et al., 2017)
166	Vitexlimolide C (7α,16-dihydroxylabda-8(17),13-dien-15,16-olide) 	*V. limonifolia*	Leaves/MeOH extract, DCM fraction		(Ban et al., 2017)
167	Andrographolide 	*V. pubescens*	Stem barks/DCM extract	Cytotoxicity against human leukemia HL-60 cells with cell survival rates of 43.6% at a concentration of 25 μM.	(Anwar, Efdi, Ninomiya, et al., 2017)

(Continues)

TABLE 2 (Continued)

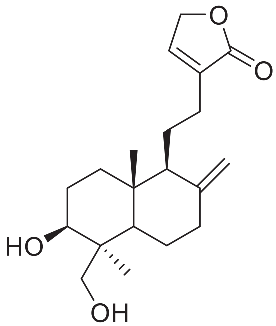
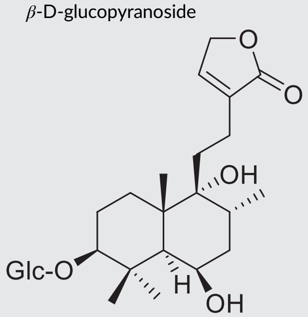
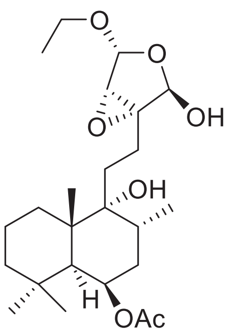
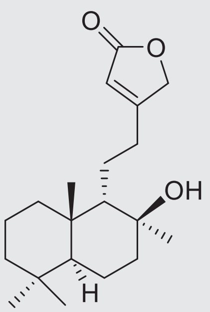
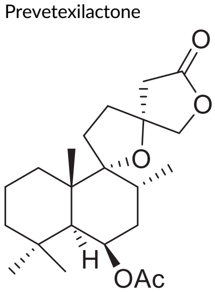
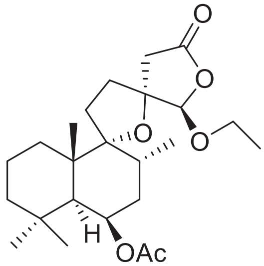
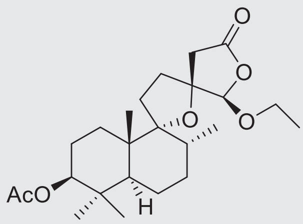
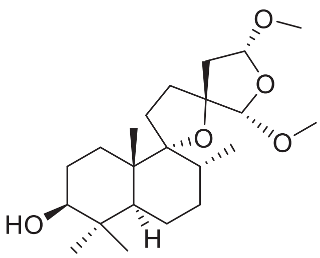
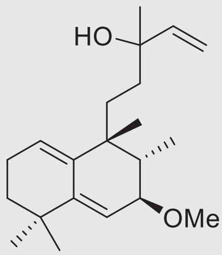
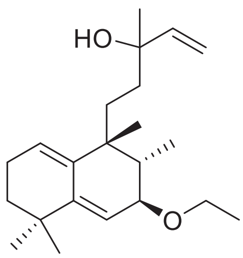
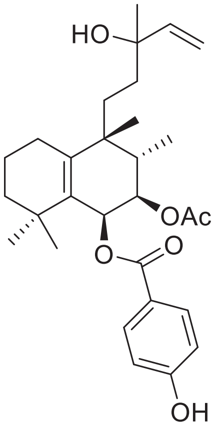
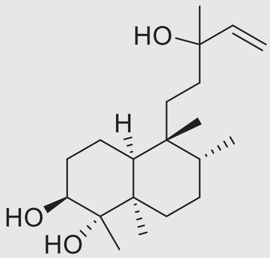
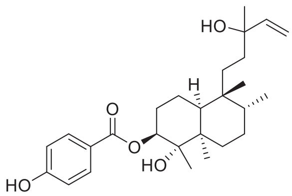
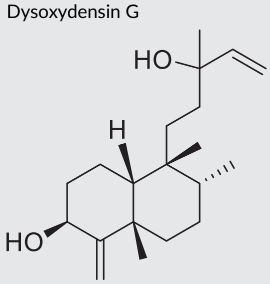
Compound No.	Compound name	Plant source	Plant parts/extraction solvent/fraction	Biological activity	References
168	14-Deoxyandrographolide 	*V. pubescens*	Stem barks/DCM extract	Cytotoxicity against human leukemia HL-60 cells with cell survival rates of 49.8% at a concentration of 25 μM.	(Anwar et al., 2017)
169	(3*S*,5*S*,6*S*,8*R*,9*R*,10*S*)-3,6,9-trihydroxy-13(14)-labdean-16,15-olide 3-*O*-*β*-D-glucopyranoside 	*V. trifolia*	Fruit/80% EtOH extract, *n*-BuOH frac tion		(Bao et al., 2018)
170	Vitextrifloxide A 	*V. trifolia*	Leaves/95% EtOH extract, EtOAc fraction		(Luo et al., 2017)
171	Vitextrifloxide B 	*V. trifolia*	Leaves/95% EtOH extract		(Luo et al., 2017)
172	Prevetexilactone 	*V. trifolia*	Leaves/95% EtOH extract		(Luo et al., 2017)

TABLE 2 (Continued)

Compound No.	Compound name	Plant source	Plant parts/extraction solvent/fraction	Biological activity	References
173	Vitextrifloxide C 	*V. trifolia*	Leaves/95% EtOH extract		(Luo et al., 2017)
174	Vitextrifloxide D 	*V. trifolia*	Leaves/95% EtOH extract		(Luo et al., 2017)
175	Vitextrifloxide E 	*V. trifolia*	Leaves/95% EtOH extract		(Luo et al., 2017)
176	Vitextrifloxide F 	*V. trifolia*	Leaves/95% EtOH extract		(Luo et al., 2017)
177	Vitextrifloxide G 	*V. trifolia*	Leaves/95% EtOH extract	Cytotoxicity against HCT 116 cells an IC_{50} value of 20.3± 2.6 μM.	(Luo et al., 2017)

(Continues)

TABLE 2 (Continued)

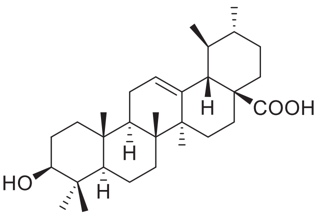
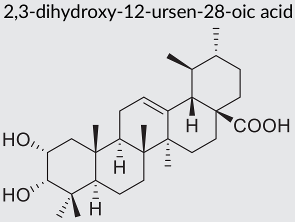
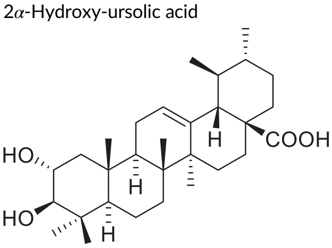
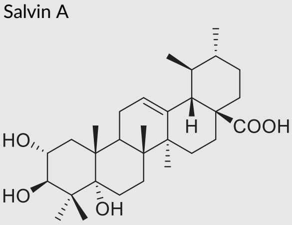
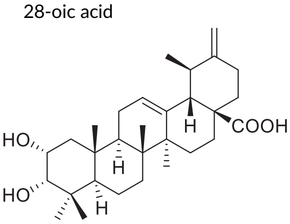
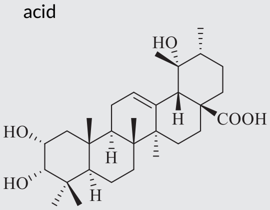
Compound No.	Compound name	Plant source	Plant parts/extraction solvent/fraction	Biological activity	References
178	Vitextrifloxide H 	*V. trifolia*	Leaves/95% EtOH extract	Cytotoxicity against HCT 116 cells an IC_{50} value of 24.6± 2.6 μM.	(Luo et al., 2017)
179	Vitexfolin B 	*V. trifolia*	Leaves/95% EtOH extract		(Luo et al., 2017)
180	Vitextrifloxide I 	*V. trifolia*	Leaves/95% EtOH extract		(Luo et al., 2017)
181	Dysoxydensin G 	*V. trifolia*	Leaves/95% EtOH extract, EtOAc fraction		(Luo et al., 2017)

Ambika and Sundrarajan (2015a, 2015b) on studying synthesis of zinc oxide nanoparticles (ZnO NPs) with *V. negundo* extract found a significant antibacterial activity against *S. aureus* and *E. coli*. In addition, the authors discussed the capacity of *Vitex* nanoparticles to bind to human albumin serum. Moreover, *Candida* species were susceptible to the essential oil from *V. agnus-castus* seeds in doses ranging between 0.13 and 2.13 mg/ml (Asdadi et al., 2015).

The labdane diterpenes, 9-hydroxy-13 (14)-labden-15,16-olide (**50**), and isoambreinolide (**162**) isolated from *V. trifolia* leaves exhibited antitubercular activity against *Mycobacterium tuberculosis* H37Rv in BACTEC-460 assay with MIC value of 100 and 25 μg/ml, respectively (Tiwari, Thakur, et al., 2013).

Nowadays, resistance to currently available antimicrobials represents a serious problem. Therefore, to develop the newer classes of antimicrobials is an urgent requirement for the humans and other domesticated animals. Extracts from the different parts of *V. doniana*, *V. rivularis*, *V. agnus-castus*, *V. rotundifolia*, and *V. negundo* were identified, and various compounds were also isolated to have their antimicrobial activity against a wide range of bacteria and fungi. Among different *vitex* mentioned here either for their antibacterial or

TABLE 3 List of triterpenoids reported from different species of *Vitex* and their biological activities

Compound No.	Compound name	Plant source	Plant parts/extraction solvent/fraction	Biological activity	References
182	Ursolic acid 	*V. negundo*	Defatted leaf powder/ MeOH extract		(Chandramu, Manohar, Krupadanam, & Dashavantha, 2003)
			Leaves/95% EtOH extract/EtOAc fraction		(Li, Su, Sun, et al., 2014)
			Powdered seeds/aqueous ethanol (80% v/v) extract, DCM fraction		(Zheng, Huang, Wu, et al., 2010)
			Powdered fruit/MeOH extract, EtOAc fraction	Brine shrimp lethality with LC_{50} value 7.7 μM.	(Fang et al. 2016b)
		V. trifolia	Leaves/MeOH extract/*n*-hexane fraction		(Tiwari, Thakur, et al., 2013)
		V. peduncularis	Leaves/acetone extract		(Sahu, Roy, & Mahato, 1984)
		V. altissima	Leaves/EtOAc extract	Exhibited moderate 5-lipoxygenase enzyme inhibitory activity (70%) at a dose of 500 μM.	(Sridhar, Rao, & Subbaraju, 2005)
183	2,3-dihydroxy-12-ursen-28-oic acid 	*V. agnus-castus*	Fruit/acetone extract		(Ono et al., 2011)
184	2α-Hydroxy-ursolic acid 	*V. agnus-castus*	Fruit/acetone extract		(Ono et al., 2011)
		V. peduncularis	Leaves/acetone extract		(Sahu et al., 1984)
		V. negundo	Leaves/MeOH, $CHCl_3$ fraction		(Rudrapaul, Sarma, Das, et al., 2014)
			Leaves/95% EtOH, EtOAc fraction		(Li et al., 2014)
185	Salvin A 	*V. cienkowskii*	Stem bark/DCM-MeOH and MeOH fraction	Vasorelaxant properties.	(Dongmo, Azebaze, Donfack, et al., 2011)
186	2α,3α-Dihydroxyurs-12, 20 (30)-dien-28-oic acid 	*V. negundo*	Leaves/95% EtOH, EtOAc fraction	NO production inhibitory activity in LPS-induced RAW 264.7 macrophages with IC_{50} value 26.1 ± 3.6 μM.	(Li et al., 2014)
187	2α,3α,19α-Trihydroxyurs-12-en-28-oic acid 	*V. negundo*	Leaves/95% EtOH extract/ EtOAc fraction		(Li et al., 2014)
			Fruits/MeOH, EtOAc fraction		(Fang et al. 2016b)

(Continues)

TABLE 3 (Continued)

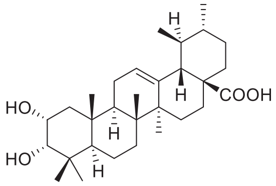
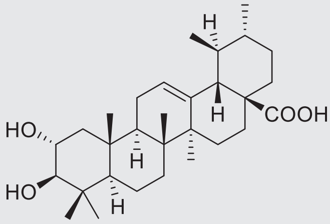
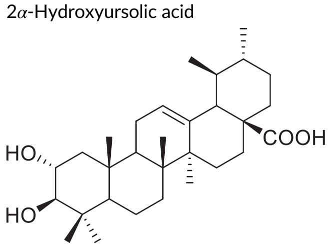
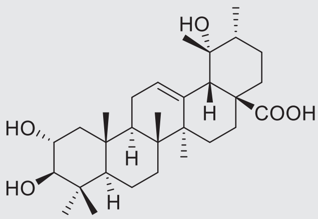
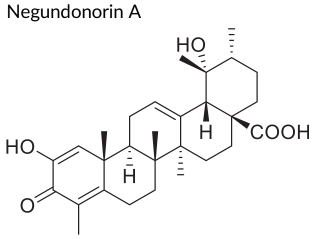
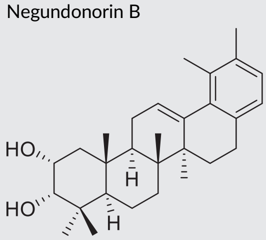
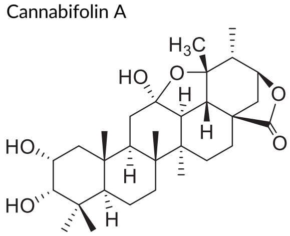
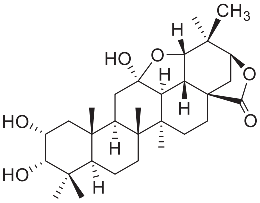
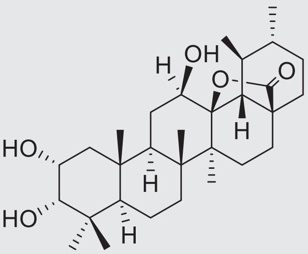
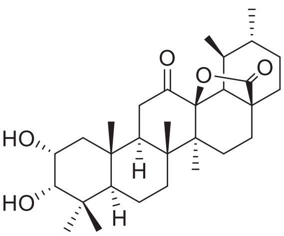
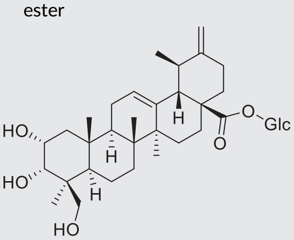
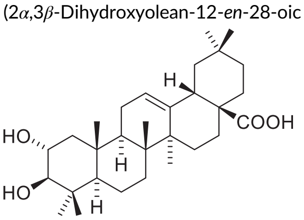
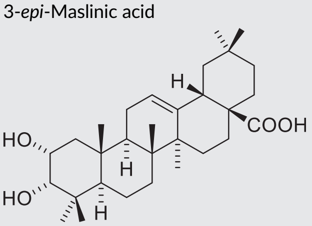
Compound No.	Compound name	Plant source	Plant parts/extraction solvent/fraction	Biological activity	References
188	2α,3α-Dihydroxyurs-12-*en*-28-oic acid 	*V. negundo*	Leaves/95% EtOH, EtOAc fraction		(Li et al., 2014)
			Fruits/MeOH extract/ EtOAc fraction	Brine shrimp lethality with LC_{50} value 14.8 μM.	(Fang et al. 2016b)
189	2α,3β-Dihydroxyurs-12-*en*-28-oic acid 	*V. trifolia*	Leaves and twigs/MeOH extract		(Huang et al., 2013)
190	2α-Hydroxyursolic acid 	*V. negundo*	Seeds/95% EtOH, DCM fraction	Moderate cytotoxic activity against HepG2 cell line with IC_{50} value 29.41 μM, HCT116 cell line with IC_{50} value 25.00 μM, A2780 cell lines with IC_{50} value 13.67μM, and mild inhibitory effects on LPS-stimulated NO production with IC_{50} value >3 μM.	(Hu et al., 2016)
191	Tormentic acid 	*V. negundo*	Leaves/95% EtOH extact/ EtOAc fraction	Moderate inhibition of nitric oxide (NO) production in lipopolysaccharide induced RAW 264.7 macrophages with IC_{50} value 24.9 ± 4.6 μM.	(M. M. Li et al., 2014)
		V. peduncularis	Leaves/MeOH extract/ $CHCl_3$ fraction		(Rudrapaul et al., 2014)
192	Negundonorin A 	*V. negundo*	Seeds/aq. EtOH 80% (v/v)	Strongly cytotoxic against ZR-75-30 cell line with IC_{50} value of 0.56 ± 0.19 μg/ml and moderate cytotoxic to HCT116, HL-60 cell lines with IC_{50} values of 14.95 ± 3.17, 9.11 ± 2.63 μg/ml, respectively.	(Zheng, Pu, et al., 2012)
193	Negundonorin B 	*V. negundo*	Seeds/aq. EtOH 80% (v/v)	Moderate cytotoxicity against HL-60 cell line having IC_{50} value 17.52 ± 3.85 μg/ml and ZR-75-30 cell line having IC_{50} value 39.26 ± 4.15μg/ml	(Zheng, Pu, et al., 2012)
194	Cannabifolin A 	*V. negundo*	Leaves/95% EtOH/EtOAc fraction		(Li et al., 2014)

TABLE 3 (Continued)

Compound No.	Compound name	Plant source	Plant parts/extraction solvent/fraction	Biological activity	References
195	Cannabifolin B 	*V. negundo*	Leaves/95% EtOH extract/ EtOAc fraction		(Li et al., 2014)
196	Cannabifolin C 	*V. negundo*	Leaves/95% EtOH, EtOAc fraction	Moderate inhibition of nitric oxide (NO) production in lipopolysaccharide-induced RAW 264.7 macrophages with IC_{50} value 34.0 ± 4.1 μM.	(Li et al., 2014)
197	Cannabifolin D 	*V. negundo*	Leaves/95% EtOH, EtOAc fraction		(Li et al., 2014)
198	2*α*,3*α*,24-Trihydroxyurs-12,20 (30)-dien-28-oic acid-28-O-*β*-D-glucopyranosyl ester 	*V. negundo*	Aerial part/75% (v/v) EtOH extract/EtOAc fraction		(Chen, Fan, Wang, & Ye, 2014)
199	Maslinic acid (2*α*,3*β*-Dihydroxyolean-12-*en*-28-oic acid) 	*V. cienkowskii*	Stem Bark/DCM-MeOH and MeOH extracts	Vasorelaxant properties.	(Dongmo et al., 2011)
		V. altissima	Leaves/EtOAc extract	Exhibited moderate 5-lipoxygenase enzyme inhibitory activity, (72%) at a dose of 500 μM	(Sridhar et al., 2005)
		V. negundo	Seeds/Aq. EtOH 80% v/v extract, DCM fraction		(Zheng, Huang, Wu, et al., 2010)
200	3-*epi*-Maslinic acid 	*V. agnus-castus*	Fruit/Acetone extract		(Ono et al., 2011)
		V. agnus-castus	Fruit/defatted MeOH extract		(Chen et al., 2011)
		V. altissima	Leaves/EtOAc		(Sridhar et al., 2005)
		V. negundo	Leaves/95% EtOH extract, EtOAc fraction	Moderate inhibition of nitric oxide production in lipopolysaccharide-induced RAW 264.7 macrophages with IC_{50} value 27.7 ± 3.3 μM.	(Li et al., 2014)

(Continues)

TABLE 3 (Continued)

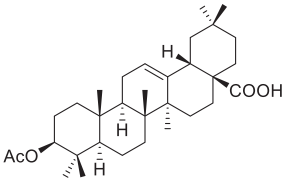
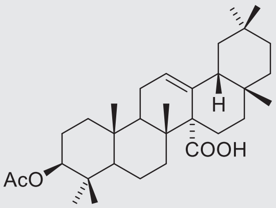
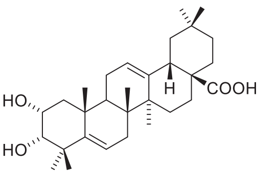
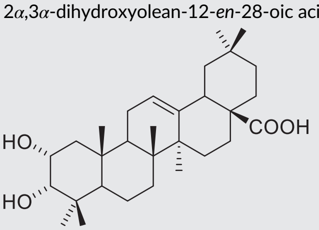
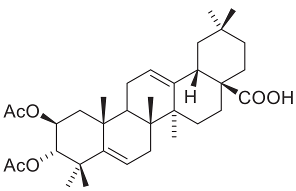
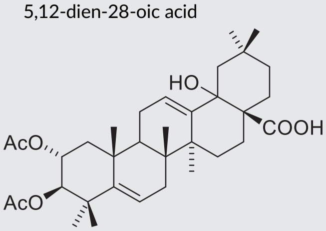
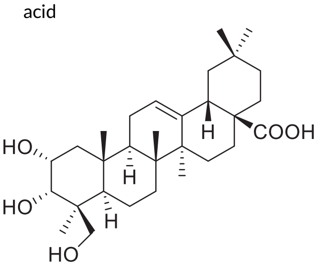
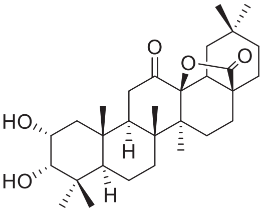
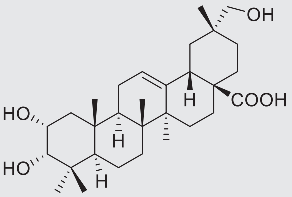
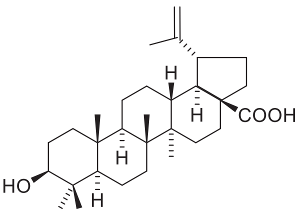
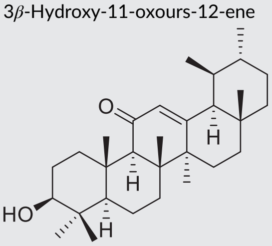
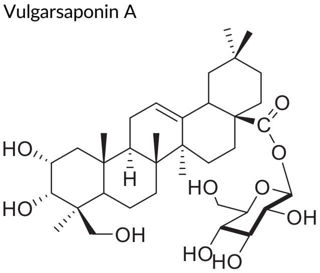
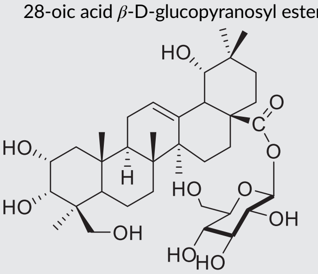
Compound No.	Compound name	Plant source	Plant parts/extraction solvent/fraction	Biological activity	References
201	Acetyloleanolic acid (oleanolic acid acetate) 	*V. negundo*	Roots/ DCM:MeOH (1:1)	*In vitro* hepatoprotective activity.	(Mishra, Pani, Rout, et al., 2014)
202	3*β*-Acetoxyolean-12-*en*-27-oic acid 	*V. negundo* *V. negundo*	Defatted seeds/$CHCl_3$ Whole plant/acetone		(Chawla, Sharma, Handa, & Dhar, 1992) (Verma, Siddiqui, & Aslam, 2011)
203	2*α*,3*α*–Dihydroxyolean-5, 12-dien-28-oic acid 	*V. negundo*	Defatted seeds/$CHCl_3$ Roots/MeOH	Mild anti-inflammatory activity.	(Chawla, Sharma, Handa, & Dhar, 1992) (Srinivas, Rao, Rao, & Raju, 2001)
204	2*α*,3*α*-dihydroxyolean-12-*en*-28-oic acid 	*V. negundo*	Fruits/MeOH, EtOAc fraction Calli/80% Ethanol, EtOAc fraction	Brine shrimp lethality with LC_{50} value 29.4 μM.	(Fang et al. 2016b) (Noel & Dayrit, 2005)
205	2*β*,3*α*-Diacetoxyoleana-5,12-dien-28-oic acid 	*V. negundo*	Defatted seeds/$CHCl_3$, Roots/MeOH		(Chawla, Sharma, Handa, & Dhar, 1992) (Srinivas et al., 2001)
206	2*α*,3*β*-Diacetoxy-18-hydroxyoleana-5,12-dien-28-oic acid 	*V. negundo* *V. negundo*	Defatted seeds/$CHCl_3$, Roots/MeOH		(Chawla, Sharma, Handa, & Dhar, 1992) (Srinivas et al., 2001)
207	2*α*,3*α*,24-trihydroxyolean-12-*en*-28-oic acid 	*V. negundo*	Leaves/95% EtOH extract/ EtOAc fraction	Moderate inhibition of nitric oxide (NO) production in lipopolysaccharide-induced RAW 264.7 macrophages with IC_{50} value 40.5 ± 4.9 μM.	(Li et al., 2014)

TABLE 3 (Continued)

Compound No.	Compound name	Plant source	Plant parts/extraction solvent/fraction	Biological activity	References
208	Cannabifolin E 	*V. negundo*	Leaves/95% EtOH extract/ EtOAc fraction		(Li et al., 2014)
209	Cannabifolin F 	*V. negundo*	Leaves/95% EtOH extract/ EtOAc fraction		(Li et al., 2014)
210	Betulinic acid 	*V. negundo*	Defatted leaf powder/ MeOH extract		(Chandramu et al., 2003)
			Seeds/Aq. EtOH 80% v/v, DCM fraction		(Zheng, Huang, Wu, et al., 2010)
		V. trifolia	Leaves and twigs/MeOH, EtOAc fraction		(Huang, Zhong, Xie, et al., 2013)
211	3*β*-Hydroxy-11-oxours-12-ene 	*V. negundo*	Leaves/70% EtOH		(Qiu et al., 2016)
212	Vulgarsaponin A 	*V. negundo*	Aerial part/75% (v/v) EtOH extract/EtOAc fraction		(Chen et al., 2014)
			Leaves/95% EtOH extract/ EtOAc fraction		(Li, Li, SunJ, et al., 2016)
213	2*α*,3*α*,19*α*,24-Tetrahydroxyolea-12-en-28-oic acid *β*-D-glucopyranosyl ester 	*V. negundo*	Leaves/95% EtOH, EtOAc fraction		(Li et al., 2016)

(Continues)

TABLE 3 (Continued)

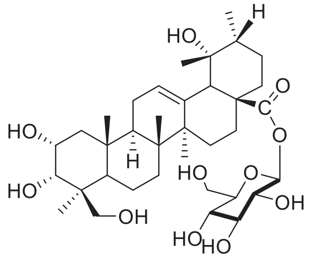
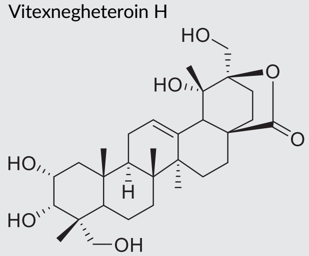
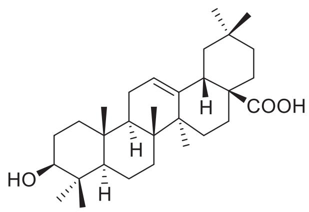
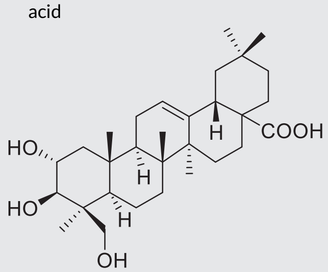
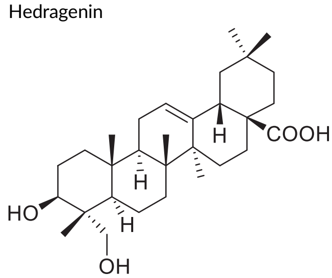
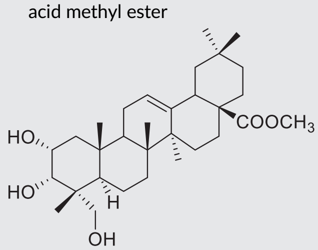
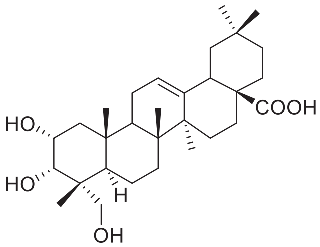
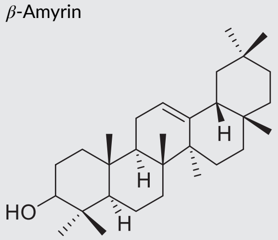
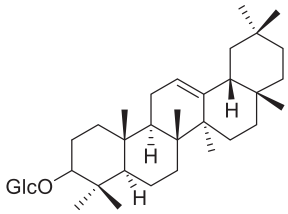
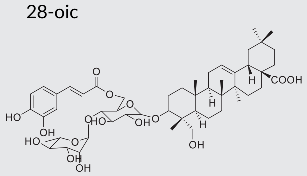
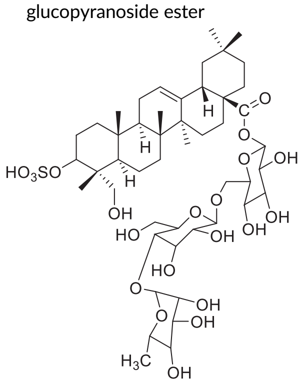
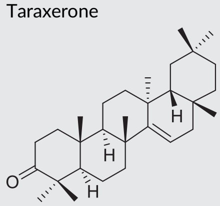
Compound No.	Compound name	Plant source	Plant parts/extraction solvent/fraction	Biological activity	References
214	2α,3α,19α,24 -Tetrahydroxyurs-12-*en*-28-oic acid β-D-glucopyranosyl ester 	*V. negundo*	Leaves/95% EtOH, EtOAc fraction		(Li et al., 2016)
215	Vitexnegheteroin H 	*V. negundo*	Seeds/aq. ethanol (95% v/v) extract/EtOAc fraction		(Hu et al., 2016)
216	Oleanolic acid 	*V. negundo*	Seeds/aq. ethanol (80% v/v)/DCM fraction		(Zheng, Huang, Wu, et al., 2010)
			Fruits/MeOH extract/ EtOAc fraction		(Fang et al. 2016b)
		V. trifolia	Calli/80% ethanol extract/ EtOAc fraction		(Noel & Dayrit, 2005)
			Leaves/ethanol extract, *n*-BuOH fraction		(Mohamed, Abdou, Hamed, & Saad, 2012)
		V. cienkowskii	Stem Bark/DCM-MeOH	Vasorelaxant activity.	(Dongmo et al., 2011)
217	2α,3β,24-Trihydroxyolean-12-en-28-oic acid 	*V. trifolia*	Stems/leaves		(Liu, Chen, Wang, et al., 2014)
218	Hedragenin 	*V. trifolia*	Leaves/ethanol extract, n-BuOH fraction	Strong cytotoxic activity on brine shrimp lithely bioassay with LC_{50} value 50.0 mg/L and on Hep-G2 cell line with IC_{50} value 9.0 mg/L.	(Mohamed et al., 2012)
219	2α,3α,23-Trihydroxyolean-12-en-28-oic acid methyl ester 	*V. negundo*	Callus culture/80% ethanol extract/EtOAc fraction		(Noel & Dayrit, 2005)

TABLE 3 (Continued)

Compound No.	Compound name	Plant source	Plant parts/extraction solvent/fraction	Biological activity	References
220	2α,3α,23-Trihydroxyolean-12-*en*-28-oic acid 	*V. negundo*	Callus culture/80% ethanol extract/EtOAc fraction		(Noel & Dayrit, 2005)
221	β-Amyrin 	*V. trifolia*	Leaf/ethanol extract, *n*-BuOH fraction		(Mohamed et al., 2012)
		V. negundo	Callus culture/80% ethanol extract/EtOAc fraction		(Noel & Dayrit, 2005)
222	β-Amyrin-3-*O*- glucopyranoside 	*V. trifolia*	Leaf/ethanol extract, *n*-BuOH fraction		(Mohamed et al., 2012)
223	23-Hydroxy-3α-*O*-α-L-rhamnopyranosyl-(1‴→4″)-*O*-[β-D-(E-6‴-*O*-Caffeoyl)-glucopyranoside]-oxy-olean-12-*en*-28-oic 	*V. trifolia*	Leaf/ethanol, *n*-BuOH fraction	Strong cytotoxic activity on brine shrimp lithely bioassay with LC_{50} value 41.0 mg/L and on Hep-G2 cell line with IC_{50} value 7.5 mg/L.	(Mohamed et al., 2012)
224	23-Hydroxy-3α-(*O*-Sulfate-oxy)-olean-12-*en*-28-oic acid *O*-α-L-rhamnopyranosyl-(1‴→4″)-*O*-β-D-glucopyranosyl-(1″→6″)-*O*-β-D-glucopyranoside ester 	*V. trifolia*	Leaf/ethanol extract, *n*-BuOH fraction		(Mohamed et al., 2012)
225	Taraxerone 	*V. trifolia*	Leaves, twigs/ MeOH extract, petroleum ether fraction		(Huang, Zhong, Xie, et al., 2013)

(Continues)

TABLE 3 (Continued)

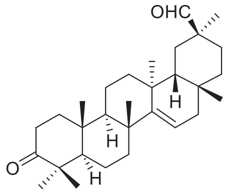
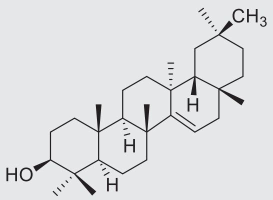
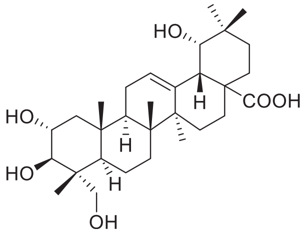
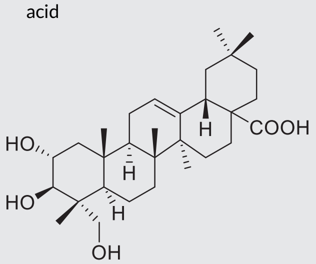
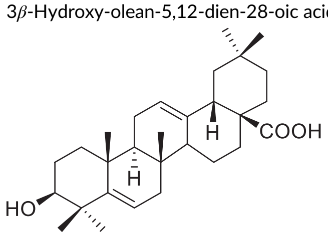
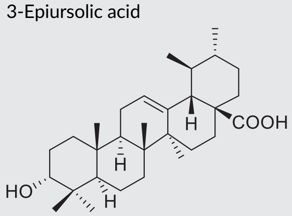
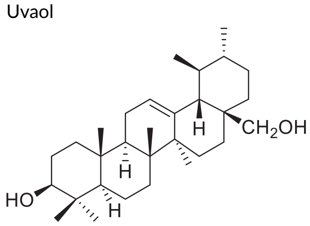
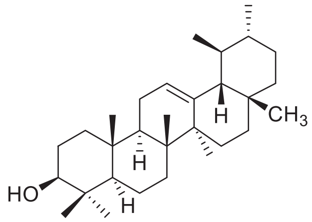
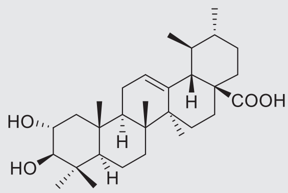
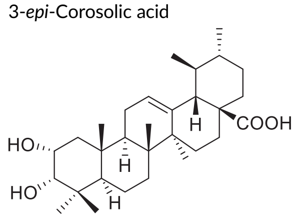
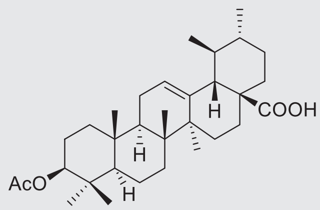
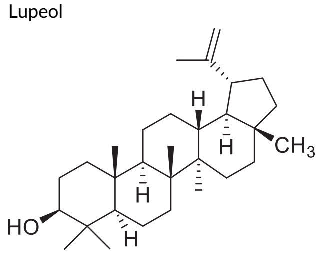
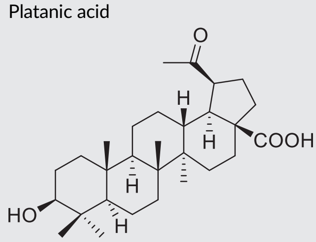
Compound No.	Compound name	Plant source	Plant parts/extraction solvent/fraction	Biological activity	References
226	1-Oxotaraxer-14-*en*-30-al 	*V. trifolia*	Leaves, twigs/MeOH extract, petroleum ether fraction		(Huang, Zhong, Xie, et al., 2013)
227	Taraxerol 	*V. trifolia*			(Chen, Xie, Yao, et al., 2010)
228	2α,3β,19α,23-Tetrahydroxyolean-12-*en*-28-oic acid 	*V. negundo*	Seeds		(Wang, He, Zeng, et al., 2012)
229	2α,3β,23-Trihydroxyolean-12-*en*-28-oic acid 	*V. negundo*	Seeds		(Wang et al., 2012)
230	3β-Hydroxy-olean-5,12-dien-28-oic acid 	*V. negundo*	Bark/acetone extract		(Verma et al., 2011)
231	3-Epiursolic acid 	*V. trifolia*	Leaves, twigs/MeOH extract, EtOAc fraction	Mild cytotoxicity against human pancreatic cancer cells PANC-1, human leukemia cells K562, and pancreatic carcinoma cells BxPC-3	(Huang, Zhong, et al., 2013)
		V. trifolia	Stem/leaves		(Liu et al., 2014)
232	Uvaol 	*V. trifolia*	Stem/leaves		(Liu et al., 2014)
		V. cauliflora	Aerial parts/EtOH extract, $CHCl_3$ fraction		(Rasamison et al., 2010)

TABLE 3 (Continued)

Compound No.	Compound name	Plant source	Plant parts/extraction solvent/fraction	Biological activity	References
233	α-Amyrin 	*V. trifolia*	Leaves/MeOH extract, hexane fraction		(Tiwari, Thakur, et al., 2013)
234	Corosolic acid 	*V. trifolia*	Leaves/MeOH extract, *n*-BuOH fraction		(Tiwari, Thakur, et al., 2013)
		V. negundo	Aerial part/75% (v/v) EtOH extract, EtOAc fraction		(J. Chen et al., 2014)
		V. negundo	Powdered fruit/MeOH, EtOAc fraction		(Fang et al. 2016b)
		V. altissima	Leaves/ethyl acetate	Exhibited moderate 5-lipoxygenase enzyme inhibitory activity (80%) at a dose of 500 μM	(Sridhar et al., 2005)
235	3-*epi*-Corosolic acid 	*V. altissima*	Leaves/ethyl acetate	Exhibited moderate 5-lipoxygenase enzyme inhibitory activity (79%) at a dose of 500 μM	(Sridhar et al., 2005)
		V. negundo	Seeds/ 80% EtOH(v/v), CH_2Cl_2 fraction	Modest cytotoxicity against HL-60 cell line with IC_{50} value 21.30 ±2.20 μg/ml and ZR-75-30 human cancer cell line with IC_{50} value 28.41 ± 5.31 μg/ml	(Zheng, Pu, et al., 2012)
236	Ursolic acid acetate 	*V. trifolia*	Leaves/ethanolic extract		(Jangwan, Aquino, Mencherini, et al., 2013)
237	Lupeol 	*V. trifolia*	Leaves and twigs/MeOH, Pet. ether extract		(Huang, Zhong, et al., 2013)
238	Platanic acid 	*V. trifolia*	Leaves/ethanolic extract		(Jangwan et al., 2013)

(Continues)

TABLE 3 (Continued)

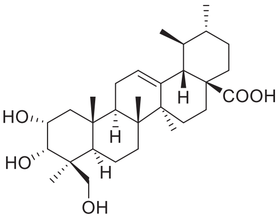
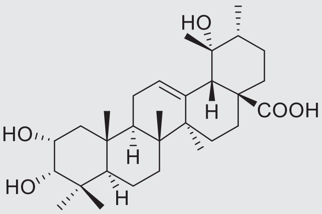
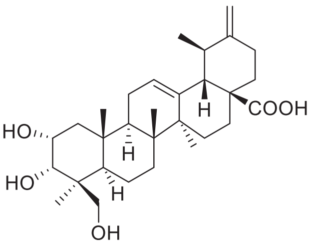
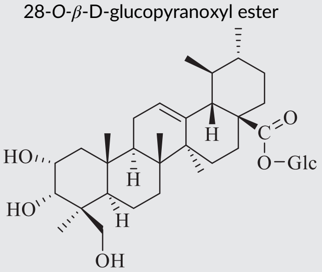
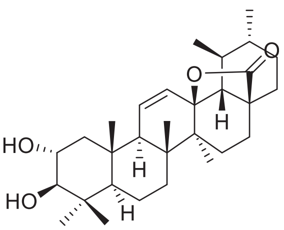
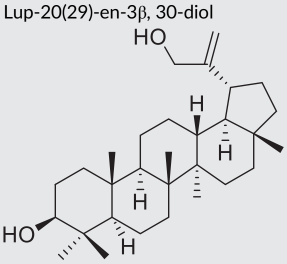
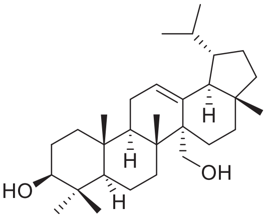
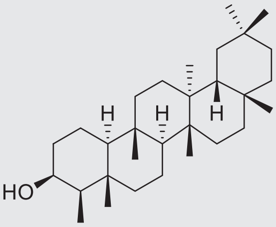
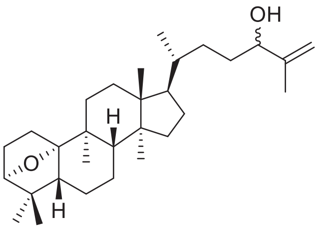
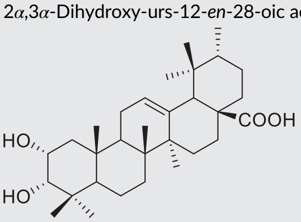
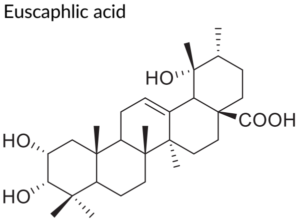
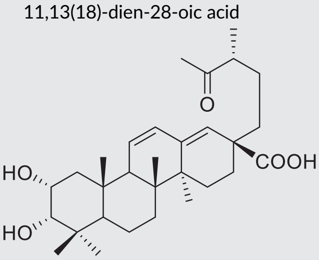
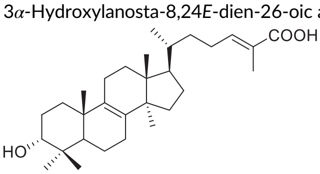
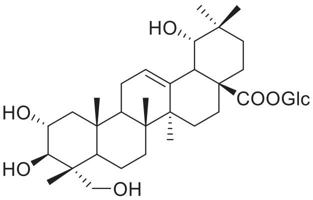
Compound No.	Compound name	Plant source	Plant parts/extraction solvent/fraction	Biological activity	References
239	2α,3α,24-Trihydroxyurs-12-*en*-28-oic acid 	*V. trifolia* *V. altissima*	Stem, leaves Leaves/EtOAc		(Liu et al., 2014) (Sridhar et al., 2005)
240	Euscaphic acid 	*V. altissima*	Leaves/EtOAc fraction	Exhibited moderate 5-lipoxygenase enzyme inhibitory activity (55%) at a dose of 500 μM.	(Sridhar et al., 2005)
241	2α,3α,24-Trihydroxyurs-12, 20(30)-dien-28-oic acid 	*V. altissima*	Leaves/EtOAc fraction		(Sridhar et al., 2005)
242	2α,3α,24-Trihydroxyurs-12-*en*-28-oic acid-28-*O*-β-D-glucopyranoxyl ester 	*V. negundo*	Aerial part/75% (v/v) EtOH extract, EtOAc fraction		(J. Chen et al., 2014)
243	Ilelatifol D 	*V. agnus-castus*	Fruit/MeOH extract		(Chen et al., 2011)
244	Lup-20(29)-en-3β, 30-diol 	*V. negundo*	Seeds/aq. ethanol extract, DCM fraction		(Zheng, Huang, Wu, et al., 2010)

TABLE 3 (Continued)

Compound No.	Compound name	Plant source	Plant parts/extraction solvent/fraction	Biological activity	References
245	Obtusalin 	*V. negundo*	Seeds/aq. ethanol extract, DCM fraction		(Zheng, Huang, Wu, et al., 2010)
246	Epifriedelinol 	*V. peduncularis*	Leafs/MeOH extract	teria.	(Kannathasan, Senthilkumar, & Venkatesalu, 2015)
247	(24*R*/*S*)-24-Hydroxy-3α, 10α-epoxy-9-*epi*-cuurbita-25-ene 	*V. negundo*	Fruits/40% ethanol	Inhibitory effect against K-562 cell line with IC_{50} value of 15.2 μM and against A-549 cell line with IC_{50} value of 25.2 μM.	(Huang, Qing, et al., 2013)
248	2α,3α-Dihydroxy-urs-12-*en*-28-oic acid 	*V. limonifolia*	Leaves/MeOH extract, DCM fraction		(Ban et al., 2017)
249	Euscaphlic acid 	*V. limonifolia*	Leaves/MeOH extract, DCM fraction		(Ban et al., 2017)
250	18,19-Seco,2α,3α-dihydroxy-19-oxo-urs-11,13(18)-dien-28-oic acid 	*V. limonifolia*	Leaves/MeOH extract, DCM fraction		(Ban et al., 2017)
251	3α-Hydroxylanosta-8,24*E*-dien-26-oic acid 	*V. trifolia*	Leaves/hot MeOH extract		(Ban, Thoa, Linh, et al., 2018)

(Continues)

TABLE 3 (Continued)

Compound No.	Compound name	Plant source	Plant parts/extraction solvent/fraction	Biological activity	References
252	Arjunglucoside 	*V. negundo*	Seeds/90% EtOH extract, DCM fraction		(Hu et al., 2016)

antifungal activity *V. negundo* is one with both the antibacterial and antifungal activities. This particular medicinal plant may take place in the pharma industry as an important source of antimicrobial agent in the coming days.

5.1.3 | Anticancer activity

The flavonoid casticin (**292**) isolated from the fruits of *V. rotundifolia* showed significant cytotoxicity against human lung cancer cells (PC-12) and human colon cancer cells (HCT 116) with GI_{50} values of 114 and 119 ng/ml, respectively, in MTT assay. The standard drug cisplatin showed GI_{50} of 111 and 794 ng/ml, against PC-12 and HCT 116 cells, respectively (Ono et al., 2002). Casticin (**292**) also significantly inhibited gallbladder cancer cell proliferation in a dose- and time-dependent manner (Ling, Jiao, Feng, et al., 2017).

Vitexicarpin (also known as casticin) (**292**) isolated from the leaves of *V. negundo* showed antiproliferative activity against KB, LNCaP, and Lul (human lung) cancer cells with ED_{50} values of 0.5, 0.5, and 0.7 μg/ml, respectively (Díaz et al., 2003).

Negundonorin A (**192**) isolated from *V. negundo* seeds showed strong cytotoxicity against breast cancer (ZR-75-30) cells with IC_{50} value of 0.56 ± 0.19 μg/ml, while negunfurol (**430**) isolated from the same plant exhibited potent cytotoxicity against HL-60 cells with IC_{50} of 0.94 ± 0.26 μg/ml (Zheng, Pu, et al., 2012). The compound (6-hydroxy-4-(4-hydroxy-3-methoxyphenyl)-3-hydroxymethyl-7-methoxy-3,4-dihydro-2-naphthaldehyde) **(371)** was isolated from *V. negundo* seeds and exhibited cytotoxic activity against HepG2 comparable to positive control (Hu et al., 2016). A clerodane-type diterpene named acuminolide (**140**) isolated from *V. cofassus* Reinw. ex Blume exhibited antiproliferative activity against human tumor cells (lung carcinoma, breast cancer strains, and epidermoid carcinoma lines) with IC_{50} values ranging from 6.4 to 11.4 μM (Rasyid et al., 2017).

Methanolic extract of *V. negundo* showed lethal concentration (LC_{50}) of (660.85 ± 74.86 mg/ml) for 50% mortality of brine shrimp *A. salina* in *Artemia nauplii* cytotoxicity assay (Prakash et al., 2016).

Ethanolic extract from *V. trifolia* shows significant anticarcinogenic effect *in-vitro* by rendering 85% protection to hepatic microsomes against the degranulatory attack by the carcinogen 3,8-diamino-5-ethyl-6-phenylphenanthridinium bromide (EB) in rat hepatic microsomal degranulation method (Mathankumar, Tamizhselvi, Manickam, & Purohit, 2015).

Vitexicarpin (**292**) isolated from the fruits of *V. rotundifolia* showed significant *in-vitro* antiangiogenic activity by inhibiting vascular-endothelial growth factor (VEGF)-induced endothelial cell (EC) proliferation, migration, and capillary-like tube formation on matrigel in a dose-dependent manner (0.1–5.0 μM) (Zhang, Liu, Zhao, et al., 2013).

5.1.4 | Antioxidant activity

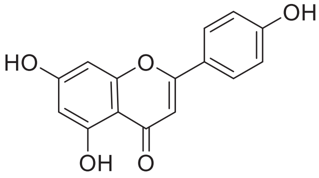
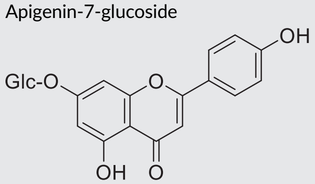
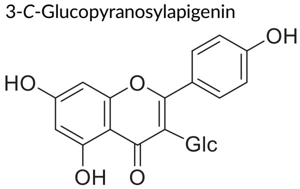
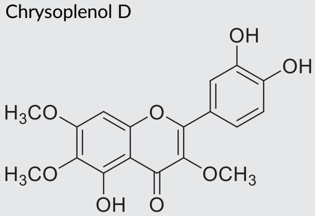
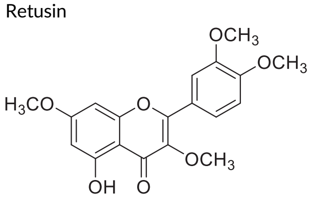
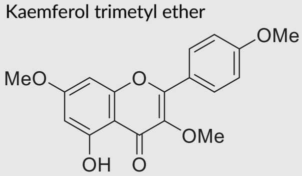
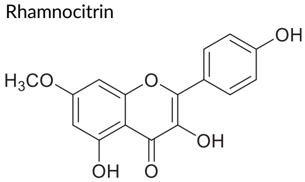
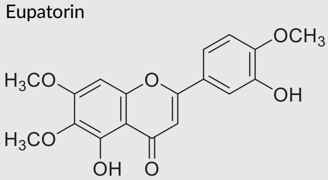
6′-*O*-*trans*-caffeoylnegundoside (**14**), 2′-*O*-*p*-hydroxybenzoylgardoside (**22**) and 2′-*O*-*p*-hydroxybenzoyl-6′-*O*-*trans*-caffeoyl-8-epiloganic acid (**8**) isolated from *V. altissima* leaves exhibited potent antioxidant activity, both in superoxide free-radical scavenging assay (using NBT method) (IC_{50}, 24.3, 32.0, and 31.9 μM, respectively) and in DPPH radical scavenging assay (IC_{50}, 15.2, 10.9, and 11.4 μM, respectively) in comparison to the known antioxidants, BHT, and α-tocopherol, having IC_{50} values 381 and 19 μM, respectively (Sridhar et al., 2004).

Lignans isolated from the seeds of *V. negundo* showed antioxidant activity both in lipid peroxidation and DPPH methods. The antioxidant activity was higher with the DPPH method. Among the tested lignans, vitedoamine A (**356**), 6-hydroxy-4-(4-hydroxy-3-methoxyphenyl)-3-hydroxymethyl-7-methoxy-3,4-dihydro-2-naphthaldehyde (**371**), and vitrofolal F (**366**) showed radical scavenging activity similar to α-tocopherol (standard antioxidant) in the DPPH assay (Ono et al., 2004).

The lignans, vitecannasides A (**374**) and B (**375**) and the flavonoids, isoorientin (**267**), and orientin (**269**) isolated from the fruits of *V. cannabifolia* showed stronger antioxidant activity than that of L-cysteine in the DPPH assay. The activity of iso-orientin (**267**) and orientin **(269)** was more than that of α-tocopherol (standard antioxidant) in the same assay (Yamasaki et al., 2008).

Vitex honey obtained from *V. negundo* var. *heterophylla* showed a strong scavenger action of the DPPH radical with IC_{50} values ranging from 44.18 to 55.21 mg ml^{-1} and also demonstrated a ferric reducing antioxidant power and ferrous ion-chelating activity (Wang, Li, Cheng, et al., 2015). Methanolic extract from *V. doniana* Sweet fruit pulp (1.0 mg/ml) demonstrated significant antioxidant activity on the DPPH radical, superoxide ion, hydrogen peroxide, and hydroxyl radical, with

TABLE 4 List of flavonoids reported from different species of *Vitex* and their biological activities

Compound No.	Compound name	Plant source	Plant parts/extraction solvent/fraction	Biological activity	References
253	Apigenin 	*V. pinnata*	Leaves		(Kamal, Clements, Gray, & Ebel, 2011)
		V. agnus-castus	Fruits/MeOH	Dose-dependent receptor binding to delta and mu opioid receptors.	(S.-N. Chen et al., 2011)
			Finely ground seed/aqueous ethanol 70% (v/v)-BNO 1095	Specific ligands for the ERβ.	(Jarry et al., 2006)
254	Apigenin-7-glucoside 	*V. negundo*	Leaves, seeds, roots		(Mingqing Huang, Zhang, Xu, et al., 2015)
255	3-*C*-Glucopyranosylapigenin 	*V. negundo*	Seeds/ 95% EtOH extract, DCM fraction	Moderate inhibitory effects on α-glucosidase (IC_{50}, 49.91 ± 4.42 μM); strong ABTS radical scavenging activity (IC_{50}, 2.37 ± 0.04 μM) and weaker DPPH scavenging activity {DPPH assay (IC_{50}, 100>μM)	(Hu et al., 2017)
256	Chrysoplenol D 	*V. trifolia*	Leaves/MeOH extract, $CHCl_3$ fraction		(Tiwari, Thakur, et al., 2013)
257	Retusin 	*V. pinnata*	Leaves/hexane	Antibacterial activity against *Microbacterium marinum*.	(Kamal et al., 2011)
258	Kaemferol trimetyl ether 	*V. pinnata*	Leaves		(Kamal et al., 2011)
259	Rhamnocitrin 	*V. quinata*	Leaves/MeOH extract, EtOAc fraction		(Kamal et al., 2011)
260	Eupatorin 	*V. agnus-castus*	Seeds/70% Aq. EtOH		(Jarry et al., 2006)

(Continues)

TABLE 4 (Continued)

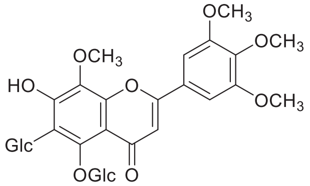
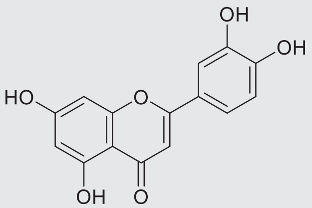
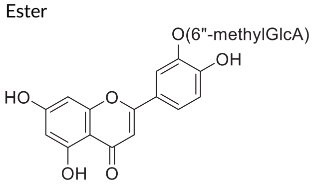
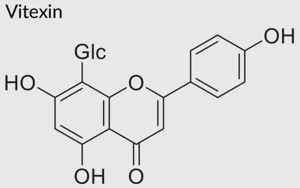
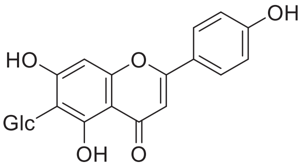
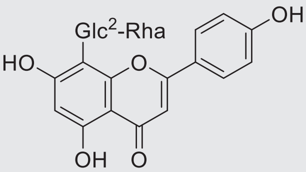
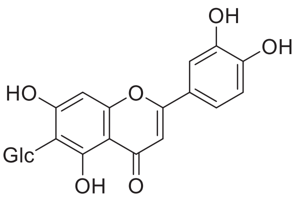
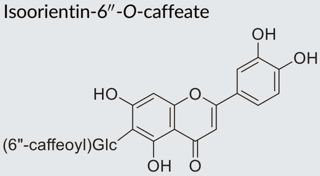
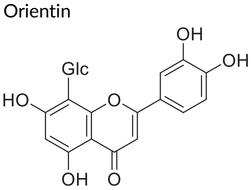
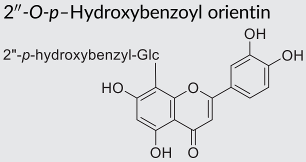
Compound No.	Compound name	Plant source	Plant parts/extraction solvent/fraction	Biological activity	References
261	6-*C*-Glucosyl-5-*O*-rhamnopyranosyl-trimethoxy-wogonin 	*V. negundo*	Stem Bark/EtOAc		(Subramanian & Misra, 1979)
262	Luteolin 	*V. pinnata*	Leaves		(Kamal et al., 2011)
			Leaves/MeOH, EtOAc fraction		(Rudrapaul et al., 2014)
		V. negundo	Leaves/EtOH extract, *n*-BuOH fraction	Moderate antifungal activity with MIC 25 μg/ml.	(Sathiamoorthy et al., 2007)
			Leaves/95% EtOH extract, EtOAc fraction	Strong radical scavenging activity {DPPH assay (IC_{50}, 3.51 ± 0.09 μM), ABTS assay (IC_{50}, 0.86 ± 0.01 μM)} and moderate a-glucosidase inhibitory effect (IC_{50}, 1.62 ± 0.13 μM).	(Hu et al., 2017)
			Whole plant/MeOH extract, EtOAc fraction	Exhibited cytotoxicity against cancer cell lines and Hedgehog (Hh) signaling pathway inhibitor.	(Arai et al., 2013)
		V. agnus-castus	Fruit/MeOH	Dose-dependent receptor binding to delta and mu opioid receptors.	(S.-N. Chen et al., 2011)
		V. trifolia	Leaves and twigs/MeOH	Cytotoxicity against human pancreatic cancer cells PANC-1, human leukemia cells K562, and pancreatic carcinoma cells BxPC-3.	(Ming-Yu Huang et al., 2013)
		V. rotundifolia	Fruit/EtOH extract, EtOAc fraction		(Wu et al., 2010)
263	4′,5,7-Trihydroxy-3′-*O*-β-D-glucuronic acid-6″-methyl Ester 	*V. negundo*	Leaves/ethanol extract, *n*-BuOH fraction	Antifungal activity against *Trichophyton mentagrophytes* and *Cryptococcus neoformans* at MIC 6.25 μg/ml	(Sathiamoorthy et al., 2007)
264	Vitexin 	*V. peduncularis*	Leaves/90% EtOH extract		(Sahu et al., 1984)
		V. peduncularis	Leaves/MeOH extract, EtOAC fraction		(Rudrapaul et al., 2014)
		V. negundo	Roots/MeOH extract		(Srinivas et al., 2001)
		V. trifolia	Leaves/MeOH extract, BuOH fraction		(Tiwari, Thakur, et al., 2013)
		V. altissima	Leaves/EtOAc extract	Moderate antioxidant activity, both in NBT (IC_{50}, 62 μg/ml) and DPPH (IC_{50}, 43 μg/ml) free radical scavenging tests.	(Sridhar et al., 2005)

TABLE 4 (Continued)

Compound No.	Compound name	Plant source	Plant parts/extraction solvent/fraction	Biological activity	References
265	Isovitexin 	*V. negundo*	Roots/MeOH		(Srinivas et al., 2001)
			Leaves/95% EtOH, *n*-BuOH fraction	Moderate radical scavenging {DPPH assay (IC_{50}, 50.63 ± 1.51 μM) ABTS assay (IC_{50}, 1.70 ± 0.03 μM)} and α-glucosidase inhibitory effect (IC_{50}, 4.60 ± 0.05 μM).	(Hu et al., 2017)
		V. peduncularis	Leaves/MeOH extract, EtOAC fraction		(Rudrapaul et al., 2014)
		V. agnus-castus	Seeds/aqueous ethanol 70% extract (v/v)		(Jarry et al., 2006)
266	Vitexin 2″-rhamnoside 	*V. negundo*	Whole plant		(Mingqing Huang et al., 2015)
267	Iso-orientin 	*V. cannabifolia*	Fruit/MeOH	DPPH radical scavenging activiity.	(Yamasaki et al., 2008)
		V. negundo	Leaves/ethanol extract, *n*-BuOH fraction	Antifungal activity against *Trichophyton mentagrophytes* at 2 μg/ml concentration.	(Sathiamoorthy et al., 2007)
		V. negundo	Seeds/ 95% EtOH, DCM fraction	Stronger DPPH radical scavenging activity.	(Hu et al., 2017)
		V. polygama	Leaves/hydroalcoholic extract, *n*-BuOH fraction		(Gallo, Vieira, Fernandes, et al., 2008)
		V. agnus-castus	Seeds/ aqueous ethanol 70% (v/v)		(Jarry et al., 2006)
268	Isoorientin-6″-*O*-caffeate 	*V. negundo*	Seeds/ 95% EtOH, DCM fraction	Potent antioxidant {DPPH assay (IC_{50}, 3.38 ± 0.21 μM), ABTS assay (IC_{50}, 0.75 ± 0.01 μM)} and α-glucosidase inhibitory effects (IC_{50}, 0.24 ± 0.02 μM).	(Hu et al., 2017)
269	Orientin 	*V. cannabifolia*	Fruit/MeOH	Free radical scavenging activity	(Yamasaki et al., 2008)
		V. polygama	Leaves/hydroalcoholic extract, BuOH fraction		(Gallo et al., 2008)
		V. negundo	Seeds/ 95% EtOH extract, DCM fraction	Strong antioxidant activity {DPPH assay (IC_{50}, 12.30 ± 0.54 μM), ABTS assay (IC_{50}, 0.86 ± 0.03 μM)} and weaker α-glucosidase inhibitory effects (IC_{50}, 10.47 ± 0.31 μM)	(Hu et al., 2017)
270	2″-*O*-*p*–Hydroxybenzoyl orientin 	*V. altissima*	Leaves/EtOAc extract		(Sridhar et al., 2005)

(Continues)

TABLE 4 (Continued)

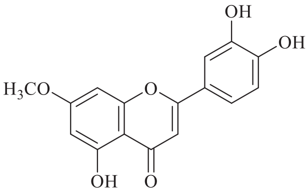
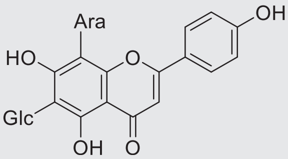
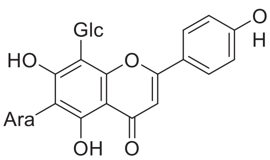
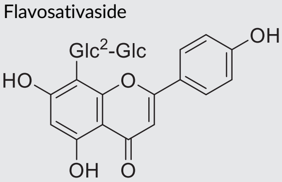
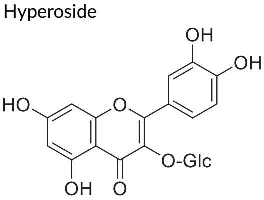
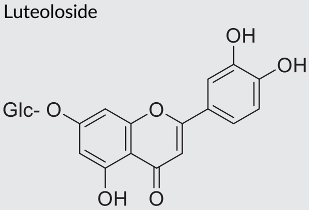
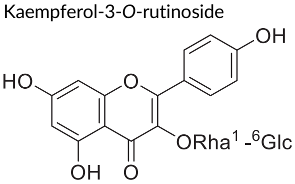
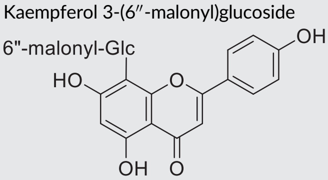
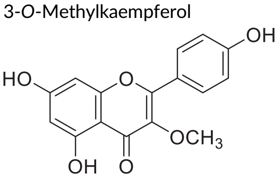
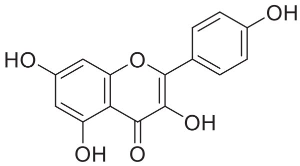
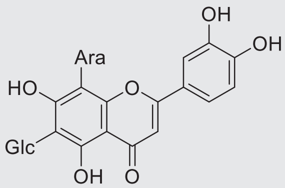
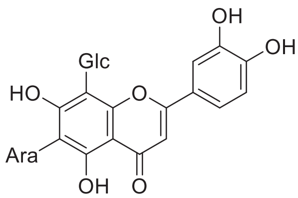
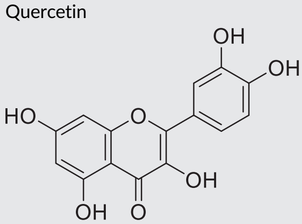
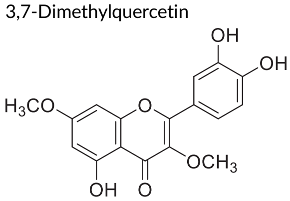
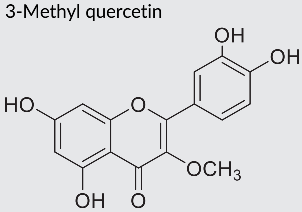
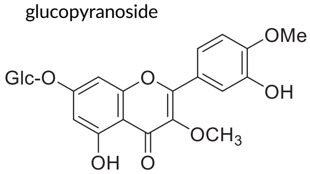
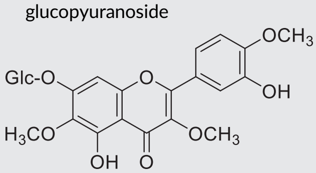
Compound No.	Compound name	Plant source	Plant parts/extraction solvent/fraction	Biological activity	References
271	Luteolin-7-methyl ether 	*V. agnus-castus*	Aerial parts/EtOH:H_2O (7:3, v/v) extract, EtOAC fraction		(Aissaoui, Algabr, Mezhoud, et al., 2016)
272	Schaftoside 	*V. polygama* *V. negundo*	Leaves/hydroalcoholic extract, *n*-BuOH fraction Roots/70% methanol–water (v/v)		(Gallo et al., 2008) (Mingqing Huang et al., 2015)
273	Isoschaftoside 	*V. polygama* *V. negundo*	Leaves/hydroalcoholic extract, *n*-BuOH fraction Roots/70% methanol–water (v/v)		(Gallo et al., 2008) (Mingqing Huang et al., 2015)
274	Flavosativaside 	*V. negundo*	Roots/70% methanol–water (v/v)		(Mingqing Huang et al., 2015)
275	Hyperoside 	*V. negundo*	Roots/70% methanol–water (v/v)		(Mingqing Huang et al., 2015)
276	Luteoloside 	*V. negundo*	Roots/70% methanol–water (v/v)		(Mingqing Huang et al., 2015)
277	Kaempferol-3-*O*-rutinoside 	*V. negundo*	Roots/70% methanol–water (v/v)		(Mingqing Huang et al., 2015)
278	Kaempferol 3-(6″-malonyl)glucoside 	*V. negundo*	Roots/70% methanol–water (v/v)		(Mingqing Huang et al., 2015)
279	3-*O*-Methylkaempferol 	*V. agnus-castus*	Fruit/MeOH (90%) extract	Dose-dependent delta and mu opioid receptor binding.	(S.-N. Chen et al., 2011)

TABLE 4 (Continued)

Compound No.	Compound name	Plant source	Plant parts/extraction solvent/fraction	Biological activity	References
280	Kaempferol 	*V. agnus-castus*	Fruit/MeOH (90%) extract		(S.-N. Chen et al., 2011)
		V. rotundifolia	Fruit/EtOH extract, EtOAc fraction		(Wu et al., 2010)
281	Carlinoside 	*V. polygama*	Leaves/hydroalcoholic extract, *n*-BuOH fraction		(Gallo et al., 2008)
282	Isocarlinoside 	*V. polygama*	Leaves/hydroalcoholic extract, *n*-BuOH fraction		(Gallo et al., 2008)
283	Quercetin 	*V. negundo*	Leaves/95% EtOH extract, EtOAc fraction	Strong antioxidant activity {DPPH assay (IC_{50}, >100 μM), ABTS assay (IC_{50}, 2.08 ± 0.10 μM)} and moderate α-glucosidase inhibitory effect (IC_{50}, 4.27 ± 0.05 μM).	(Hu et al., 2017)
		V. rotundifolia	Fruit/EtOH extract/ EtOAc fraction		(Wu et al., 2010)
284	3,7-Dimethylquercetin 	*V. agnus-castus*	Fruit/MeOH (90%) extract		(S.-N. Chen et al., 2011)
285	3-Methyl quercetin 	*V. agnus-castus*	Fruit/MeOH (90%) extract		(S.-N. Chen et al., 2011)
286	3,4′-Dimethoxy quercetin 7-*O*-glucopyranoside 	*V. trifolia*	Leaves/EtOH extract, EtOAc fraction	Strong antioxidant capacity with SC_{50} value 13.19 ± 0.20 μg/ml.	(Mohamed et al., 2012)
287	3,6,4′-Trimethoxy quercetin 7-*O*-glucopyuranoside 	*V. trifolia*	Leaves/EtOH extract, EtOAc fraction		(Mohamed et al., 2012)

(Continues)

TABLE 4 (Continued)

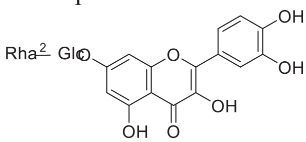
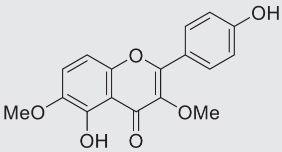
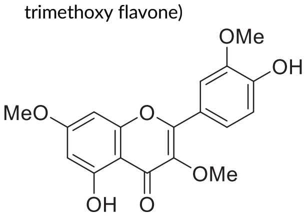
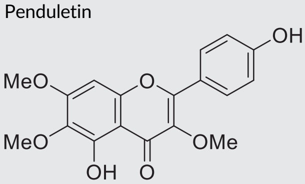
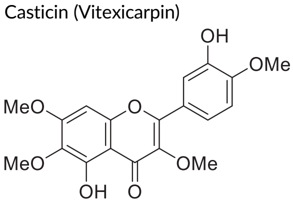
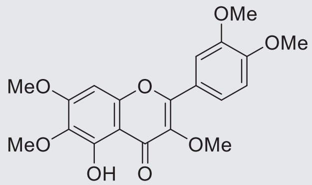
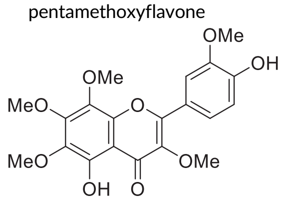
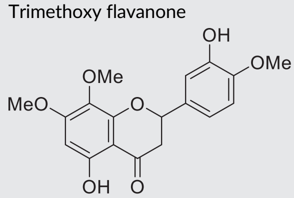
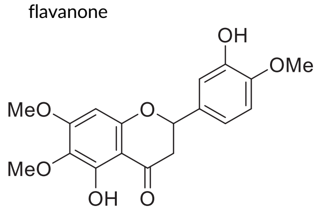
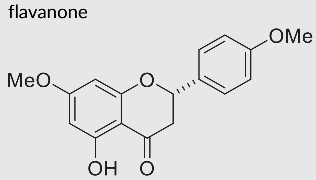
Compound No.	Compound name	Plant source	Plant parts/extraction solvent/fraction	Biological activity	References
288	Quercetin 7-*O*-neohespridoside neohespridoside 	*V. trifolia*	Leaves/EtOH extract, EtOAc fraction	Strong antioxidant capacity with SC_{50} value 29.48 ± 0.47 μg/ml	(Mohamed et al., 2012)
289	Peduncularisin (5,4′-dihydroxy-3,6-dimethoxy flavone) 	*V. peduncularis*	Leaves/acetone extract		(Sahu et al., 1984)
290	Pachypodol (5,4′-dihydroxy-3,7,3′-trimethoxy flavone) 	*V. peduncularis*	Leaves/acetone extract		(Sahu et al., 1984)
291	Penduletin 	*V. agnus-castus*	Seeds/aqueous ethanol 70% (v/v)	Specific ligand for the estrogen Receptor *β*.	(Jarry et al., 2006)
		V. negundo	Fruit/defatted MeOH extract		Chen et al., 2011)
			Aerial parts/EtOH extract		(Y. J. Chen et al., 2012)
		V. simplicifolia	Leaves/MeOH extract	Exhibited promising trypanocidal activity with IC_{50} value 13.8 μg/ml and cytotoxicity 14.0 μg/ml.	(Nwodo, Okoye, Lai, et al., 2015)
292	Casticin (Vitexicarpin) 	*V. agnus-castus*	Fruit/acetone	Mild Antioxidative activity. Dose-dependent delta and mu opioid receptor binding.	(Ono et al., 2011)
			Fruit/defatted MeOH extract		(S.-N. Chen et al., 2011)
			Fruit/MeOH extract, EtOAC fraction		(S. Li et al., 2013)
			Seeds/aqueous ethanol 70% (v/v)		(Jarry et al., 2006)
		V. rotundifolia	Fruit/MeOH extract/*n*-hexan fraction	Significantly reduced vascular inflammation through inhibition of ROS–NF-κB pathway in vascular endothelial cells.	(Lee, Lee, Kim, et al., 2012)
			Fruit/MeOH extract	Growth inhibitory activity against human lung cancer cells (PC-12) and human colon cancer cells (HCT116) using the MTT assay.	(Ono et al., 2002)
			Fruit/EtOH extract/ EtOAc fraction		(Wu et al., 2010)
			Fruit/MeOH extract	Potential angiogenesis inhibitor.	(Zhang, Liu, Zhao, et al., 2013)

TABLE 4 (Continued)

Compound No.	Compound name	Plant source	Plant parts/extraction solvent/fraction	Biological activity	References
		V. negundo	Leaves/$CHCl_3$ fraction	Exhibited broad cytotoxicity in a human cancer cell line panel.	(Díaz, Chávez, Lee, et al., 2003)
		V. fructus	Purchased from Chromadex Inc. (Irvine, CA, USA)	Ameliorated cigarette smoke-induced acute lung inflammatory response in a murine model.	(H. Lee, Jung, Lee, et al., 2015)
		V. trifolia	Leaves/MeOH, $CHCl_3$ fraction		(Tiwari, Thakur, et al., 2013)
		V. trifolia	Leaves and twigs/MeOH extract, EtOAc fraction	Exhibited cytotoxicity against PANC-1, K562, and BxPC-3 cancer cell lines with IC_{50} values of 4.67, 0.72, and 4.01 μg/ml, respectively.	(Ming-Yu Huang et al., 2013)
293	Artemetin 	*V. rotundifolia*	Fruit/MeOH extract		(Ono et al., 2002)
		V. agnus-castus	Seeds /aqueous ethanol 70% extract (v/v)		(Jarry et al., 2006)
			Fruit/*n*-hexane		(S. Li et al., 2013)
		V. trifolia	Leaves and twigs/MeOH extract, EtOAc fraction		(Huang, Zhong, et al., 2013)
294	5,4′-Dihydroxy-3,6,7,8,3′-pentamethoxyflavone 	*V. cannabifolia*	Fruit/MeOH	DPPH radical scavenging activity.	(Yamasaki et al., 2008)
		V. negundo	Seeds/95% EtOH, DCM fraction	Moderate α-glucosidase inhibitory effect, cytotoxicity against human HepG2 and rat C6 cell lines.	(Fang et al. 2016b)
		V. negundo	Seeds/ 95% EtOH, DCM fraction	Moderate antioxidant activity {DPPH assay (IC_{50}, >100 μM) ABTS assay (IC_{50}, 2.94 ± 0.03 μM)} and α-glucosidase inhibitory effect (IC_{50}, 2.70 ± 0.12 μM).	(Hu et al., 2017)
295	5,3′-Dihydroxy-7,8,4′-Trimethoxy flavanone 	*V. negundo*	Leaves/$CHCl_3$		(Achari, Chowdhury, Dutta, & Pakrashi, 1984)
			Bark/acetone		(Verma et al., 2011)
296	5,3′-Dihydroxy-6,7,4′-trimethoxy flavanone 	*V. negundo*	Leaves/$CHCl_3$		(Achari et al., 1984)
		V. rotundifolia	Fruit/MeOH		(Ono et al., 2002)
		V. agnus-castus	Seeds/aqueous ethanol 70% extract (v/v)		(Jarry et al., 2006)
297	(*S*) -5-Hydroxy-7,4′-dimethoxy flavanone 	*V. quinata*	Leaves/MeOH extract, $CHCl_3$ fraction	Cytotoxicity with ED_{50} values of 6.7, 4.7 and 1.1 μM, respectively against a panel of three human cancer cells.	(Deng, Chin, Chai, et al., 2011)

(Continues)

TABLE 4 (Continued)

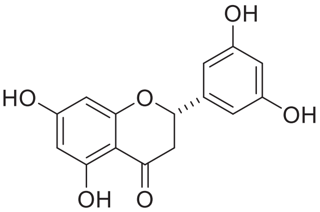
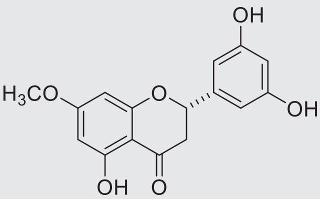
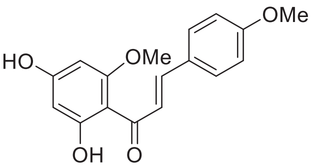
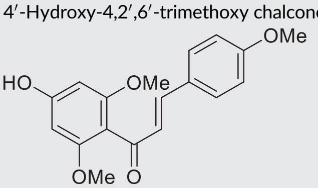
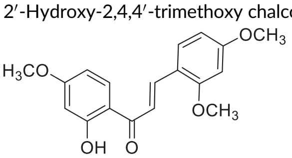
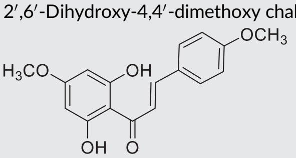
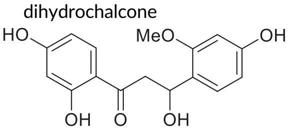
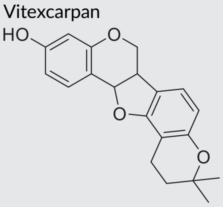
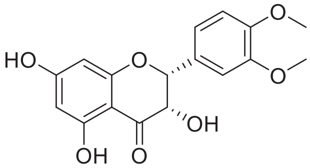
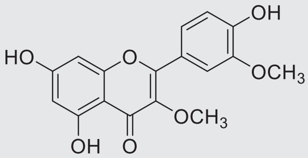
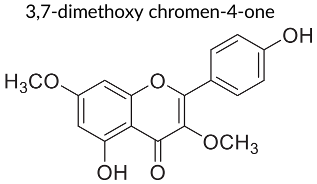
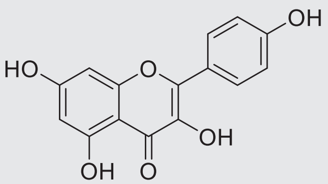
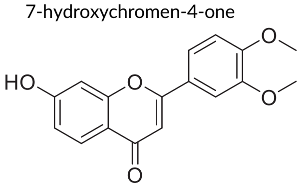
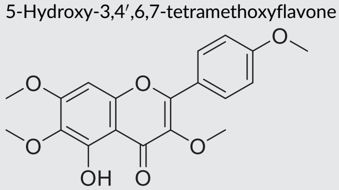
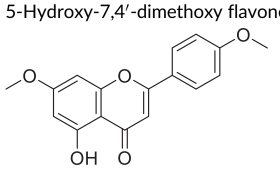
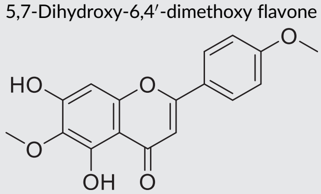
Compound No.	Compound name	Plant source	Plant parts/extraction solvent/fraction	Biological activity	References
298	5,7,3′,5′-Tetrahydroxyflavanone 	*V. agnus-castus*	Fruit/MeOH (90%) extract		(S.-N. Chen et al., 2011)
299	5,3′,5′-Trihydroxymethoxyl flavanone 	*V. agnus-castus*	Fruit/MeOH (90%) extract		(S.-N. Chen et al., 2011)
300	2′,4′-Dihydroxy-4,6′- dimethoxy-chalcone 	*V. leptobotrys*			(Thuy, Van Sung, & Adam, 2000)
301	4′-Hydroxy-4,2′,6′-trimethoxy chalcone 	*V. leptobotrys*			(Thuy et al., 2000)
302	2′-Hydroxy-2,4,4′-trimethoxy chalcone 	*V. quinata*	Leaves/MeOH extract, $CHCl_3$ fraction		(Deng et al., 2011)
303	2′,6′-Dihydroxy-4,4′-dimethoxy chalcone 	*V. quinata*	Leaves/MeOH extract, $CHCl_3$ fraction		(Deng et al., 2011)
304	4,2′,4′,β–Tetrahydroxy-6-methoxy-α, β dihydrochalcone 	*V. leptobotrys*			(Thuy et al., 2000)
305	Vitexcarpan 	*V. agnus-castus*	Aerial part/ MeOH, EtOAc fraction	Moderate inhibitory activity against urease (43.3 %) and chymotrypsin (39.8 %) enzymes, moderate (48 %) *in vitro* anti-inflammatory activity.	(Ahmad, Azam, Bashir, et al., 2010)

TABLE 4 (Continued)

Compound No.	Compound name	Plant source	Plant parts/extraction solvent/fraction	Biological activity	References
306	2-(5′-Methoxyphenyl)-3,4′,5,7-trihydroxychroman-4-one 	*V. simplicifolia*	Leaves/MeOH extract, EtOAc fraction		(Nwodo et al., 2015)
307	2-(5′-Methoxyphenyl) 4′,5,7-trihydroxy-3-methoxychromen-4-one 	*V. simplicifolia*	Leaves/MeOH extract, EtOAc fraction	Moderate trypanocidal activities.	(Nwodo et al., 2015)
308	2-(4′-Hydroxyphenyl)-5-hydroxy 3,7-dimethoxy chromen-4-one 	*V. simplicifolia*	Leaves/MeOH extract, EtOAc fraction		(Nwodo et al., 2015)
309	2-(4-Hydroxyphenyl)-3,5,7-trihydroxy chromen-4-one 	*V. simplicifolia*	Leaves/MeOH extract, EtOAc fraction		(Nwodo et al., 2015)
310	2-(3′,4′-Dimethoxyphenyl)-7-hydroxychromen-4-one 	*V. simplicifolia*	Leaves/MeOH extract, EtOAc fraction	Moderate trypanocidal activities.	(Nwodo et al., 2015)
311	5-Hydroxy-3,4′,6,7-tetramethoxyflavone 	*V. agnus-castus*	Fruit/*n*-hexane extract Fruit/*n*-hexane extract Seeds/aqueous ethanol 70% extract (v/v)		(S. Li et al., 2013) (Ono et al., 2009) (Jarry et al., 2006)
312	5-Hydroxy-7,4′-dimethoxy flavone 	*V. negundo*	Leaves/MeOH extract		(Gautam, Shrestha, Wagle, & Tamrakar, 2008)
313	5,7-Dihydroxy-6,4′-dimethoxy flavone 	*V. negundo*	Leaves/MeOH extract		(Gautam et al., 2008)

(Continues)

TABLE 4 (Continued)

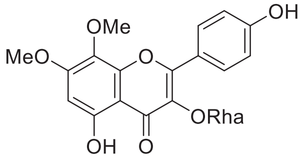
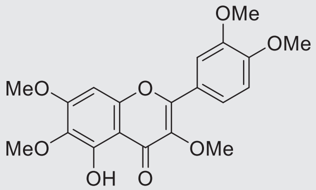
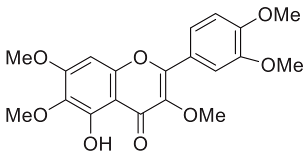
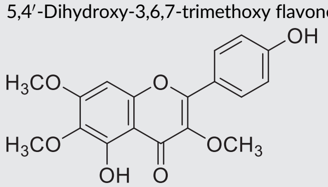
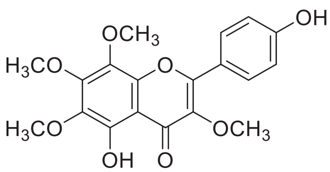
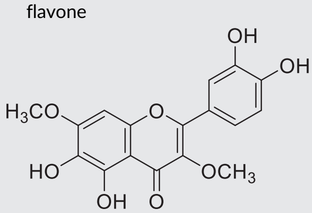
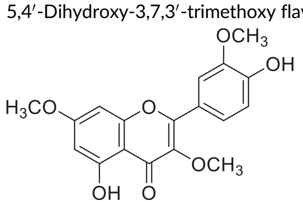
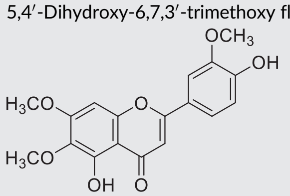
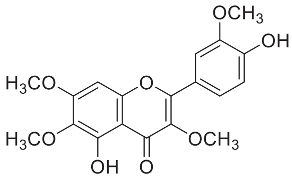
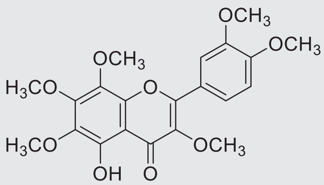
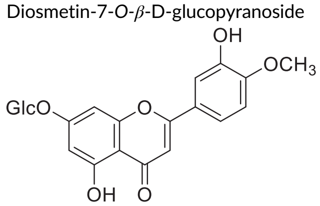
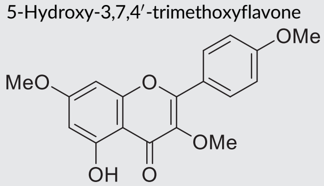
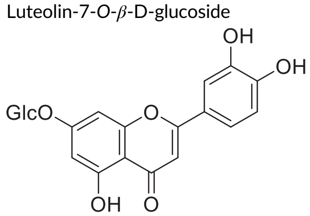
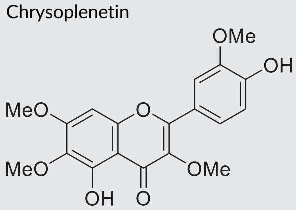
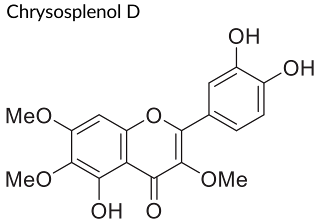
Compound No.	Compound name	Plant source	Plant parts/extraction solvent/fraction	Biological activity	References
314	7,8-Dimethyl herbacetin-3-rhamnoside 	*V. negundo*	Leaves/MeOH extract		(Gautam et al., 2008)
315	5-Hydroxy-3′,4′,3,6,7-pentamethoxy flavone 	*V. negundo*	Leaves/MeOH extract Leaves/petroleum ether extract		(Gautam et al., 2008) (A. Banerji, Chadha, & Malshet, 1969)
316	5-Hydroxy-3′,4′,3,6,7-pentamethoxy flavone 	*V. negundo*	Leaves/ethanol extract, *n*-BuOH fraction	Antifungal activity against *Cryptococcus neoformans* with MIC 12.5 μg/ml	(Sathiamoorthy et al., 2007)
317	5,4′-Dihydroxy-3,6,7-trimethoxy flavone 	*V. negundo*	Seeds/95% EtOH extract, DCM extract	Strong antioxidant activity.	(Hu et al., 2017)
318	5,4′-Dihydroxy-3,6,7,8- tetramethoxy flavone 	*V. negundo*	Fruits, seeds/ 95% EtOH, DCM extract		(Fang et al. 2016b)
319	5,6,3′,4′-Tetrahydroxy-3,7-dimethoxy flavone 	*V. negundo*	Leaves/95% EtOH, EtOAc extract	Strong antioxidant activity {DPPH assay (IC_{50}, 3.67 ± 0.12 μM), ABTS assay (IC_{50}, 1.23 ± 0.06 μM)} and moderate α-glucosidase inhibitory effect (IC_{50}, 2.11 ± 0.06 μM).	(Hu et al., 2017)
320	5,4′-Dihydroxy-3,7,3′-trimethoxy flavone 	*V. negundo*	Seeds/95% EtOH, DCM extract	Strong antioxidant activity {DPPH assay (IC_{50}, >100 μM), ABTS assay (IC_{50}, 7.57 ± 0.05 μM) and weaker α-glucosidase inhibitory effect (IC_{50}, 18.66 ± 0.84 μM).	(Hu et al., 2017)
321	5,4′-Dihydroxy-6,7,3′-trimethoxy flavone 	*V. negundo*	Seeds/95% EtOH, DCM extract	Strong antioxidant activity {DPPH assay (IC_{50}, >100 μM), ABTS assay (IC_{50}, 5.12 ± 0.05 μM) and weaker α-glucosidase inhibitory effect (IC_{50}, 9.96 ± 0.53 μM).	(Hu et al., 2017)

TABLE 4 (Continued)

Compound No.	Compound name	Plant source	Plant parts/extraction solvent/fraction	Biological activity	References
322	5,4′-Dihydroxy-3,6,7,3′-tetramethoxy flavone 	*V. negundo*	Seeds/95% EtOH extract, DCM fraction	Strong antioxidant activity {DPPH assay (IC_{50}, >100 μM) ABTS assay (IC_{50}, 2.95 ± 0.03 μM)} and moderate α-glucosidase inhibitory effect (IC_{50}, 3.51 ± 0.14 μM).	(Hu et al., 2017)
			Fruit/MeOH extract, EtOAc fraction	Weak cytotoxicity against human HepG2 and rat C6 cell lines.	(Fang et al. 2016b)
323	5-Hydroxy-3,6,7,8,3′,4′-hexamethoxy flavone 	*V. negundo*	Seeds/95% EtOH, DCM fraction	Strong antioxidant activity {DPPH assay (IC_{50}, >100 μM), ABTS assay (IC_{50}, 2.85 ± 0.06 μM)} and weaker α-glucosidase inhibitory effect (IC_{50}, 10.28 ± 1.19 μM).	(Hu et al., 2017)
		V. negundo	Fruit/MeOH extract, EtOAc fraction	Moderate cytotoxicity against human HepG2 and rat C6 cell lines.	(Fang et al. 2016b)
324	Diosmetin-7-*O*-*β*-D-glucopyranoside 	*V. negundo*	Seeds/95% EtOH extract, DCM fraction	Moderate antioxidant activity {DPPH assay (IC_{50}, >100 μM) ABTS assay (IC_{50}, 9.37 ± 0.10 μM)} and weaker α-glucosidase inhibitory effect (IC_{50}, 35.90 ± 0.36 μM).	(Hu et al., 2017)
325	5-Hydroxy-3,7,4′-trimethoxyflavone 	*V. gardneriana*	Stem barks/EtOH extract		(Vale, Gonçalves, Teixeira, et al., 2017)
326	Luteolin-7-*O*-*β*-D-glucoside 	*V. negundo*	Leaves/petroleum ether, MeOH extract		(Sharma et al., 2009)
			Seeds/95% EtOH extract, DCM fraction		(Hu et al., 2017)
327	Chrysoplenetin 	*V. negundo*	Fruit/MeOH	Cytotoxicity activity against PANC-1 human pancreatic cancer and a host of other human cancer cells.	(Awale, Linn, Li, et al., 2011)
328	Chrysosplenol D 	*V. negundo*	Fruit/MeOH	Cytotoxicity activity against PANC-1 human pancreatic cancer cells.	(Awale et al., 2011)
			Whole plant/MeOH extract, EtOAc fraction		(Arai et al., 2013)

(Continues)

TABLE 4 (Continued)

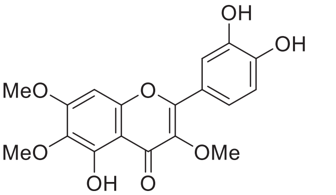
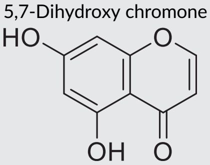
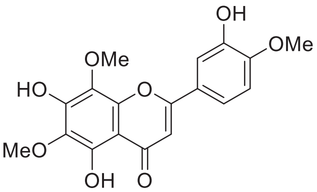
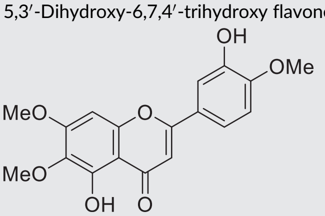
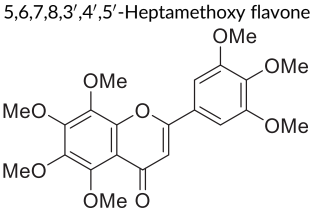
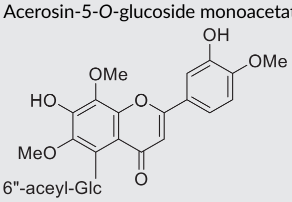
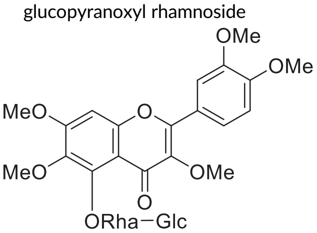
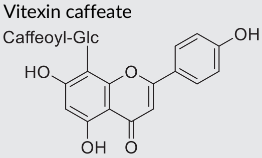
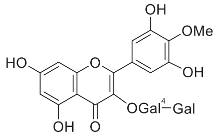
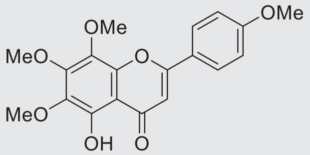
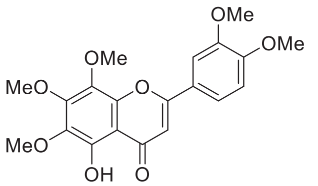
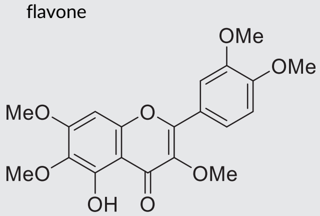
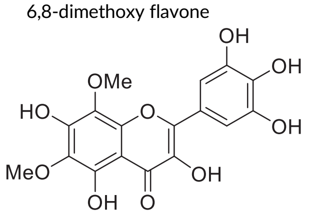
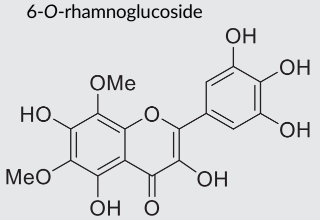
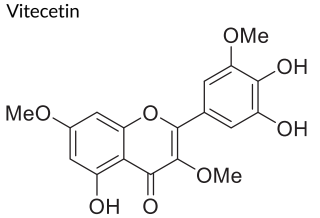
Compound No.	Compound name	Plant source	Plant parts/extraction solvent/fraction	Biological activity	References
329	4′,5-Dihydroxy-3,6,7-trimethoxy flavones 	*V. negundo*	Seeds		(Zhao, Zheng, & Qin, 2012)
330	5,7-Dihydroxy chromone 	*V. negundo*	Seeds		(Zhao et al., 2012)
331	5,7,3′-Trihydroxy-6,8,4′-trimethoxy flavone 	*V. negundo*	Leaves		(Ferdous, Jabbar, & Hasan, 1984)
332	5,3′-Dihydroxy-6,7,4′-trihydroxy flavone 	*V. negundo*	Leaves		(Ferdous et al., 1984)
333	5,6,7,8,3′,4′,5′-Heptamethoxy flavone 	*V. negundo*	Leaves		(Ferdous et al., 1984)
334	Acerosin-5-O-glucoside monoacetate 	*V. negundo*	Stem bark/ EtOAc extract		(Subramanian & Misra, 1979)
335	3,6,7,3′,4′-Pentamethoxy-5-*O*-glucopyranoxyl rhamnoside 	*V. negundo*	Stem bark/ EtOAc extract		(Misra & Subramanian, 1980)
336	Vitexin caffeate 	*V. negundo*	Stem bark/ EtOAc extract		(Misra & Subramanian, 1980)

TABLE 4 (Continued)

Compound No.	Compound name	Plant source	Plant parts/extraction solvent/fraction	Biological activity	References
337	4′-*O*-Methyl myricetin-3-*O*-[4″-*O*-β-D-galactosyl]-β-D-galactopyranoside 	*V. negundo*	Stem bark/ EtOAc extract		(Misra & Subramanian, 1980)
338	Corymbosin 	*V. negundo*	Leaves and twigs		(J. Banerji, Das, & Chakrabarty, 1988)
339	5-Hydroxy-6,7,8,3′,4′-Pentamethoxy flavones 	*V. negundo*	Leaves and twigs		(J. Banerji et al., 1988)
340	5-Hydroxy-3,6,7,3′,4′-pentamethoxy flavone 	*V. negundo*	Plant/acetone extract		(Verma et al., 2011)
341	3,4,5,7,3′,4′,5′-Hexahydroxy-6,8-dimethoxy flavone 	*V. negundo*	Leaves and twigs		(J. Banerji et al., 1988)
342	4,5-Dihydroxy-3′,4′-dimethoxy flavones-6-*O*-rhamnoglucoside 	*V. negundo*	Leaves and twigs		(J. Banerji et al., 1988)
343	Vitecetin 	*V. peduncularis*	Leaves/MeOH extract, $CHCl_3$ fraction	*In-vitro* antileishmanial activities of both *Leishmania donovani* promastigote and amastigote forms.	(Rudrapaul et al., 2014)

(Continues)

TABLE 4 (Continued)

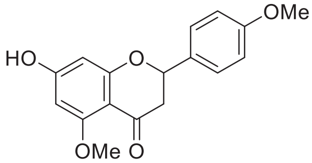
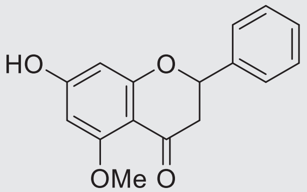
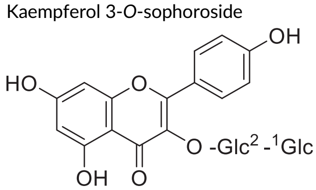
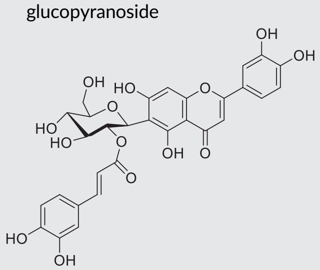
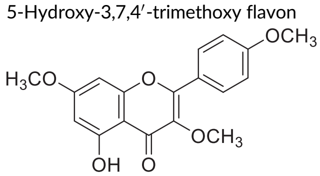
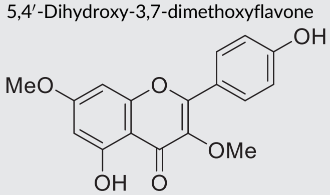
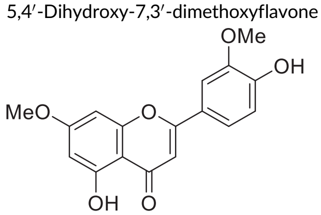
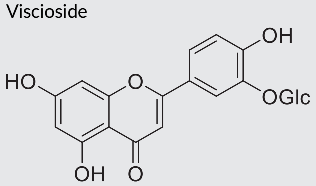
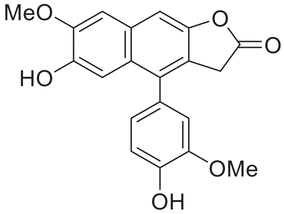
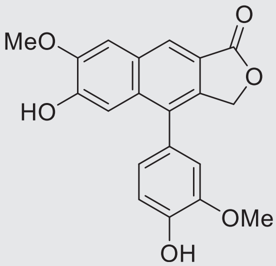
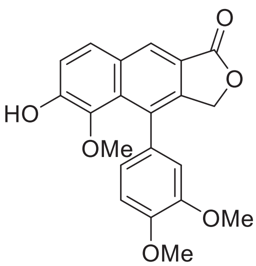
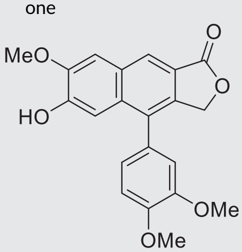
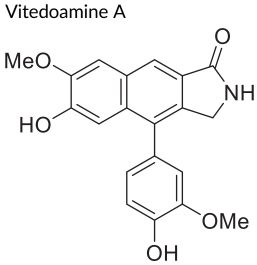
Compound No.	Compound name	Plant source	Plant parts/extraction solvent/fraction	Biological activity	References
344	Tsugafolin 	*V. leptobotrys*	Leaves and twigs/DCM extract	Weak anti-HIV activity with IC_{50} value 118 μM.	(Pan, Liu, Guan, et al., 2014)
345	Alpinetin 	*V. leptobotrys*	Leaves and twigs/DCM extract	Weak anti-HIV activity with IC_{50} value 130 μM.	(Pan et al., 2014)
346	Kaempferol 3-*O*-sophoroside 	*V. agnus-castus*	Flowers/MeOH extract, H_2O fraction		(Kırmızıbekmez & Demir, 2016)
347	Luteolin 6-*C*-(2″-*O*-trans-caffeoyl) glucopyranoside 	*V. agnus-castus*	Flowers/MeOH extract, H_2O fraction		(Kırmızıbekmez & Demir, 2016)
348	5-Hydroxy-3,7,4′-trimethoxy flavon 	*V. gardneriana*	Leaves/MeOH extract, EtOAc fraction		(Macedo, da Silva, da Silva, et al., 2019)
349	5,4′-Dihydroxy-3,7-dimethoxyflavone 	*V. limonifolia*	Leaves/MeOH extract, DCM fraction		(Ban et al., 2017)
350	5,4′-Dihydroxy-7,3′-dimethoxyflavone 	*V. limonifolia*	Leaves/MeOH extract, DCM fraction		(Ban et al., 2017)
351	Viscioside 	*V. pinnata*	Barks/EtOH extract, $CHCl_3$:MeOH (70:30) fraction		(Ata et al., 2009)

TABLE 5 List of lignans reported from different species of *Vitex* and their biological activities

Compound No.	Compound name	Plant source	Plant parts/ fraction	Biological activity	References
352	Negundin A 	*V. negundo*	Roots/MeOH	Inhibitory activity against lipoxygenase enzyme, acetyl-cholinesterase, butyryl-cholinesterase.	(Haq, Malik, Anis, et al., 2004)
353	Detetrahydroconidendrin 	*V. negundo*	Seeds/MeOH extract	DPPH free radical scavenging activity	(Ono et al., 2004)
			Fruit/MeOH, EtOAc extract		(Fang et al. 2016b)
		V. cannabifolia	Fruit/MeOH extract		(Yamasaki et al., 2008)
		V. rotundifolia	Subterranean part/MeOH extract, EtOAc fraction	Antibacterial activity against methicillin-resistant *Staphylococcus aureus* (MRSA) strains.	(Kawazoe, Yutani, Tamemoto, et al., 2001)
354	4-(3,4-Dimethoxyphenyl)-6-hydroxy-5-methoxynaphtho[2,3-c]furan-1(3*H*)-one 	*V. rotundifolia*	Subterranean part/MeOH extract, EtOAc fraction		(Kawazoe et al., 2001)
355	4-(3,4-Dimethoxyphenyl)-6-hydroxy-7-methoxynaphtho[2,3-c]furan-1(3*H*)-one 	*V. rotundifolia*	Subterranean part/MeOH extract, EtOAc fraction		(Kawazoe et al., 2001)
356	Vitedoamine A 	*V. negundo*	Seeds/MeOH extract,	DPPH free radical scavenging activity.	(Ono et al., 2004)
			Seeds/aq. EtOH (80%) extract		(Zheng, Tang, Huang, et al., 2009)
			Aerial part/EtOH-H_2O (7:3, v/v) extract		(Nie, Yu, Tao, et al., 2016)

(Continues)

TABLE 5 (Continued)

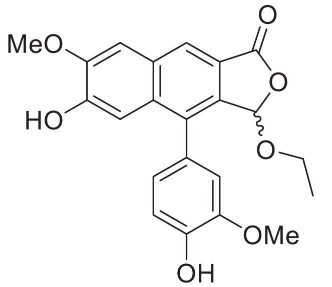
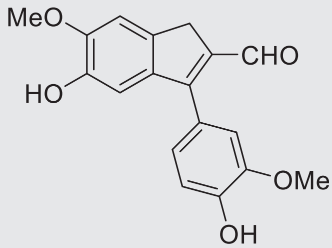
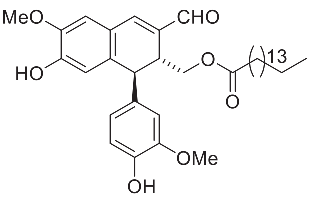
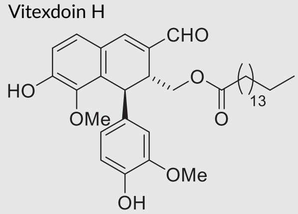
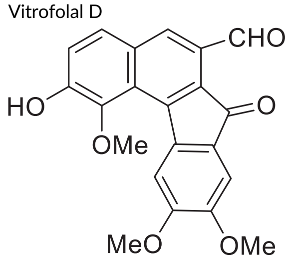
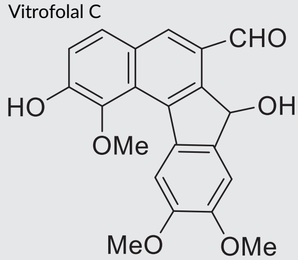
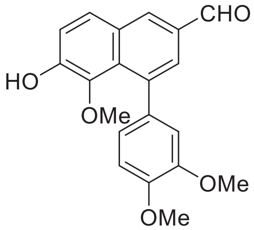
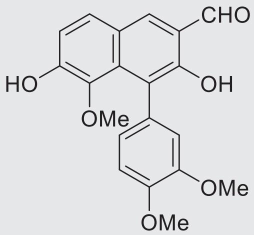
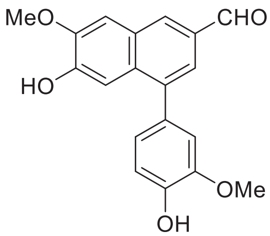
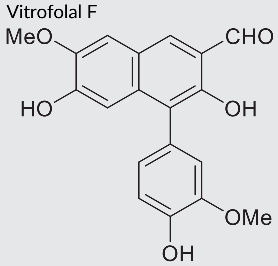
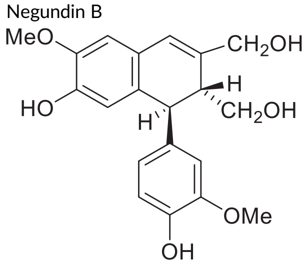
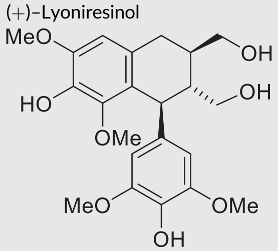
Compound No.	Compound name	Plant source	Plant parts/ fraction	Biological activity	References
357	Vitexdoin I 	*V. negundo*	Seeds/aq. EtOH (80%, v/v) extract, DCM fraction		(C.-J. Zheng, Zhang, Han, et al., 2014)
358	Vitexdoin F 	*V. negundo*	Seeds/aq. EtOH (80%, v/v) extract, DCM fraction		(C.-J. Zheng et al., 2014)
			Aerial part/EtOH-H_2O (7:3, v/v) extract		(Nie et al., 2016)
359	Vitexdoin G 	*V. negundo*	Seeds/aq. EtOH (80%, v/v) extract, DCM fraction		(C.-J. Zheng et al., 2014)
360	Vitexdoin H 	*V. negundo*	Seeds/aq. EtOH (80%, v/v) extract, DCM fraction		(C.-J. Zheng et al., 2014)
361	Vitrofolal D 	*V. rotundifolia*	Subterranean part/MeOH extract, EtOAc fraction	Antimicrobial activity of against methicillin-resistant *Staphylococcus aureus* strains.	(Kawazoe et al., 2001)
362	Vitrofolal C 	*V. rotundifolia*	Roots/MeOH extract, EtOAc fraction		(Kawazoe, Yutani, & Takaishi, 1999)
			Subterranean part/MeOH extract, EtOAc fraction	Antimicrobial activity of against methicillin-resistant *Staphylococcus aureus* strains.	(Kawazoe et al., 2001)

TABLE 5 (Continued)

Compound No.	Compound name	Plant source	Plant parts/ fraction	Biological activity	References
363	Vitrofolal A 	*V. rotundifolia*	Roots/MeOH extract, EtOAc fraction		(Kawazoe et al., 1999)
			Subterranean part/ MeOH extract, EtOAc fraction		(Kawazoe et al., 2001)
364	Vitrofolal B 	*V. rotundifolia*	Roots/MeOH extract, EtOAc fraction		(Kawazoe et al., 1999)
			Subterranean part/ MeOH extract, EtOAc fraction		(Kawazoe et al., 2001)
365	Vitrofolal E 	*V. negundo*	Seeds/MeOH extract	DPPH free radical scavenging activity.	(Ono et al., 2004)
			Roots/MeOH extract, $CHCl_3$ fraction	*In-vitro* moderate activity against butyryl-cholinesterase.	(Haq et al., 2004)
			Seeds/EtOH extract	Inhibitory activities on LPS-induced nitric oxide (NO) production in RAW264.7 cells with IC_{50} value 0.50 μM.	(Zheng, Huang, Han, et al., 2009)
		V. rotundifolia	Subterranean part/MeOH extract, EtOAc fraction		(Kawazoe et al., 2001)
		V. cannabifolia	Fruits/MeOH extract		Yamasaki et al., 2008)
366	Vitrofolal F 	*V. negundo*	Seeds/MeOH extract	DPPH free radical scavenging activity.	(Ono et al., 2004)
			Roots/MeOH, $CHCl_3$ fraction		(Haq et al., 2004)
			Seeds/EtOH extract	Strong inhibitory activities on LPS-induced nitric oxide (NO) production in RAW264.7 cells with IC_{50} value 0.11 μM.	(Zheng, Huang, et al., 2009)
		V. rotundifolia	Subterranean part/MeOH extract, EtOAc fraction		(Kawazoe et al., 2001)
		V. cannabifolia	Fruits/MeOH extract		(Yamasaki et al., 2008)
367	Negundin B 	*V. negundo*	Roots/MeOH extract	Potent inhibitory activity against lipoxygenase enzyme.	(Haq et al., 2004)
368	(+)–Lyoniresinol 	*V. negundo*	Roots/MeOH extract		(Haq et al., 2004)

(Continues)

TABLE 5 (Continued)

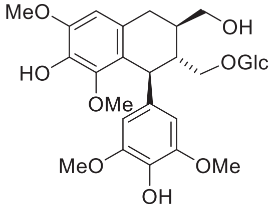
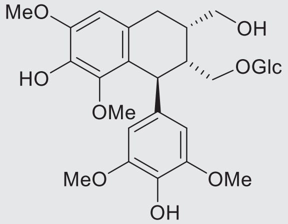
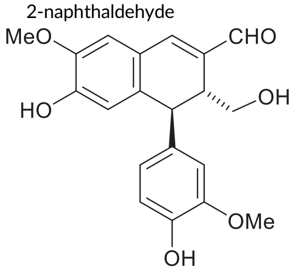
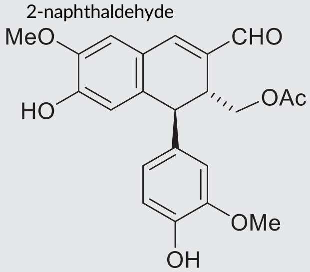
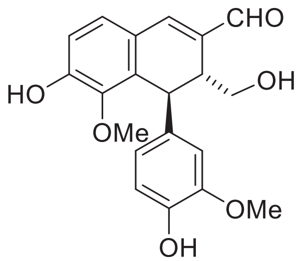
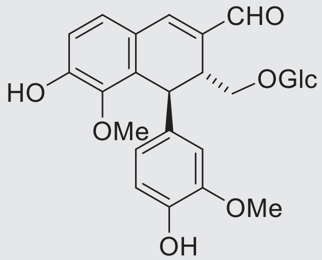
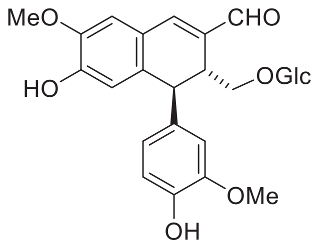
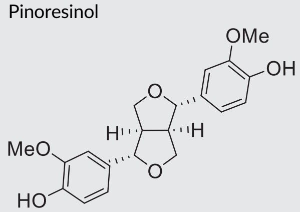
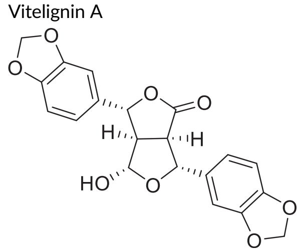
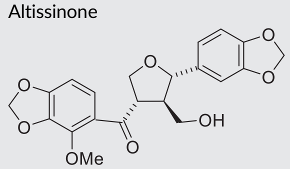
Compound No.	Compound name	Plant source	Plant parts/ fraction	Biological activity	References
369	(+)-Lyoniresinol-3a-*O*-*β*-D-glucopyranoside 	*V. negundo*	Aerial part/ EtOH extract		(Nie et al., 2016)
370	(−)-Lyoniresinol-3a-*O*-*β*-D-glucopyranoside 	*V. negundo*	Aerial Part/ EtOH extract		(Nie et al., 2016)
371	6-Hydroxy–4(4-hydroxy-3-methoxyphenyl)-3-hydroxymethyl-7-methoxy-3,4-dihydro-2-naphthaldehyde 	*V. negundo*	Seeds/MeOH extract	DPPH free radical scavenging activity.	(Ono et al., 2004)
			Defatted Seeds/$CHCl_3$ extract	Antiedema activity.	(Chawla, Sharma, Handa, et al., 1992)
			Whole plant/MeOH extract, EtOAc fraction		(Arai et al., 2013)
			Seeds/95% EtOH extract, EtOAc fraction	Cytotoxicity against human liver carcinoma (HepG2 with IC_{50}, 8.24 μM), colon carcinoma (HCT116 with IC_{50}, 57.52 μM), and ovarian carcinoma (A2780 with IC_{50}, 77.85 μM) cell lines, inhibitory activity on nitric oxide (NO) production with an IC_{50} value >1 μM and antioxidant activity in ABTS assay with IC_{50} = 1.71 ± 0.22 μM.	(Hu et al., 2016)
			Seeds/80% EtOH extract, EtOAc fraction	Inhibitory activities on LPS-induced nitric oxide (NO) production in RAW264.7 cells with IC_{50} value 3.54 μM.	(Zheng, Huang, et al., 2009)
			Seeds/80% EtOH extract, EtOAc fraction	Analgesic, antiinflammatory, and antinociceptive effect.	(Zheng, Tang, et al., 2009)
		V. cannabifolia	Aerial part/EtOH extract		(Nie et al., 2016)
			Fruit/MeOH extract		(Yamasaki et al., 2008)
372	6-Hydroxy-4-(4-hydroxy-3-methoxyphenyl)-3-acetoxymethyl-7-methoxy-3,4-dihydro-2-naphthaldehyde 	*V. negundo*	Fruit/MeOH extract, EtOAc fraction		(Fang et al. 2016b)

TABLE 5 (Continued)

Compound No.	Compound name	Plant source	Plant parts/ fraction	Biological activity	References
373	Vitedoin A 	*V. negundo*	Seeds/MeOH extract	Free radical (DPPH) scavenging activity.	(Ono et al., 2004)
			Seeds/95% EtOH extract, EtOAc fraction	Moderate cytotoxic activity against HCT116 cell line (IC_{50}, 10.18 μM), inhibitory effects on LPS-stimulated nitric oxide (NO) production (IC_{50}, >3 μM) and significant antioxidant activity in ABTS assay (IC_{50}, 1.63 ± 0.08 μM).	(Hu et al., 2016)
		V. cannabifolia	Fruit/MeOH extract, EtOAc fraction		(Fang et al. 2016b)
			Aerial Part/EtOH extract		(Nie et al., 2016)
			Fruit/MeOH extract		(Yamasaki et al., 2008)
374	Vitecannaside A 	*V. cannabifolia*	Fruit/MeOH extract	DPPH free radical scavenging activity.	(Yamasaki et al., 2008)
375	Vitecannaside B 	*V. cannabifolia*	Fruit/MeOH extract	DPPH free radical scavenging activity.	(Yamasaki et al., 2008)
		V. negundo	Seeds/95% EtOH extract, EtOAc fraction	Inhibitory effects on LPS-stimulated NO production (IC_{50}, 19.01 ± 2.49 μM) and strong ABTS radical scavenging activity (IC_{50}, 3.20 ± 0.14 μM).	(Hu et al., 2016)
			Aerial part/EtOH extract		(Nie et al., 2016)
376	Pinoresinol 	*V. cannabifolia*	Fruit/MeOH extract		(Yamasaki et al., 2008)
		V. negundo	Fruit/MeOH extract, EtOAc fraction		(Fang et al. 2016b)
377	Vitelignin A 	*V. negundo*	Seeds	Antifungal activity against *Candida albicans* (MIC 32 μg/ml), *Cryptococcus neoformans* (MIC 64 μg/ml), *and Trichophyton rubrum* (MIC 32 μg/ml)	(Zheng et al., 2011)
378	Altissinone 	*V. altissima*	Leaves/EtOAc extract		(Sridhar et al., 2005)

(Continues)

TABLE 5 (Continued)

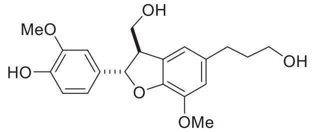
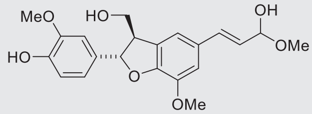
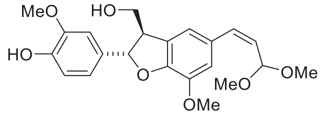
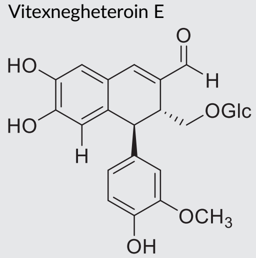
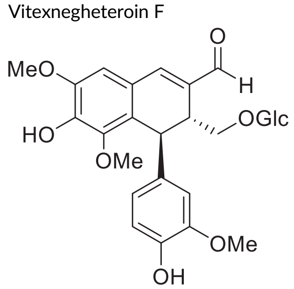
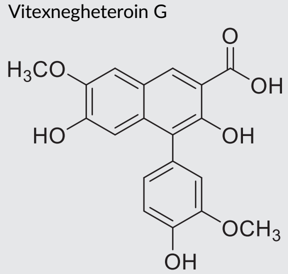
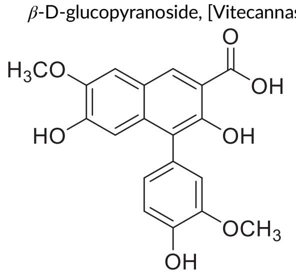
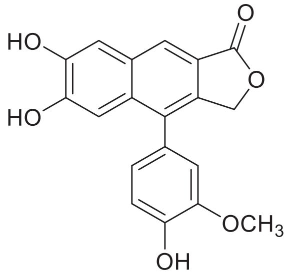
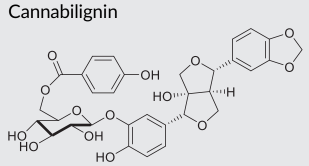
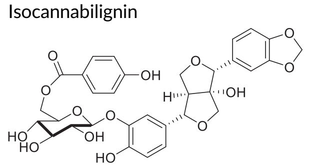
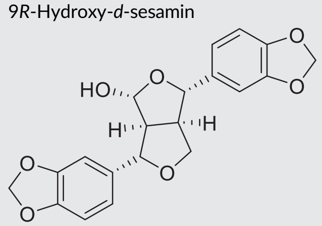
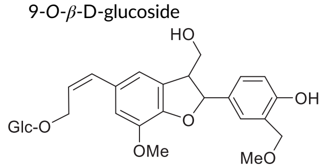
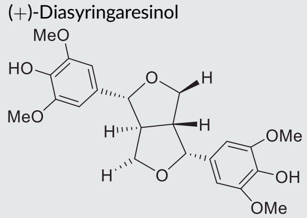
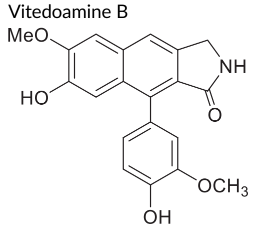
Compound No.	Compound name	Plant source	Plant parts/ fraction	Biological activity	References
379	2α,3β-7-*O*-Methylcedrusin 	*V. negundo*	Seeds/ MeOH		(Ono et al., 2004)
380	Viterolignan A 	*V. rotundifolia*	Fruit/MeOH extract, DCM soluble fraction	Inhibitory activities on LPS-induced NO production in RAW264.7 cells with IC_{50} value 21.1 μM.	(C. Lee et al., 2013)
381	Viterolignan B 	*V. rotundifolia*	Fruit/MeOH extract, DCM soluble fraction	Inhibitory activities on LPS-induced NO production in RAW264.7 cells with IC_{50} value 42.8 μM.	(C. Lee et al., 2013)
382	Vitexnegheteroin E 	*V. negundo*	Seeds/95% EtOH extract, *n*-BuOH fraction	Inhibitory effect on nitric oxide (NO) production in murine microglial BV-2 cell line by the Griess reaction with IC_{50} value 17.27 ± 6.10 μM and strong ABTS radical scavenging activity with IC_{50} value 3.20 ± 0.14 μM.	(Hu et al., 2016)
383	Vitexnegheteroin F 	*V. negundo*	Seeds/95% EtOH extract, EtOAc fraction	Weaker cytotoxic activity against three human cancer cell lines namely HepG2 (IC_{50}, 55.48 μM), HCT116 (IC_{50}, >100 μM) and A2780 (IC_{50}, >100 μM) and strong ABTS radical scavenging activity with IC_{50} value 3.20 ± 0.14 μM.	(Hu et al., 2016)
384	Vitexnegheteroin G 	*V. negundo*	Seeds/95% EtOH extract, EtOAc fraction	Inhibitory effect on nitric oxide (NO) production in murine microglial BV-2 cell line by the Griess reaction with IC_{50} value >30 μM and strong ABTS radical scavenging activity with IC_{50} value 3.20 ± 0.14 μM.	(Hu et al., 2016)
385	(3*R*,4*S*)-6-Hydroxy-4-(4-hydroxy-3-methoxyphenyl)-5,7-dimethoxy-3,4-dihydro-2-naphthaldehyde-3*a*-*O*-β-D-glucopyranoside, [Vitecannaside C] 	*V. negundo*	Aerial parts/EtOH-H_2O (7:3, v/v), EtOAc extract		(Nie et al., 2016)

TABLE 5 (Continued)

Compound No.	Compound name	Plant source	Plant parts/ fraction	Biological activity	References
386	6,7,4′-Trihydroxy-3′-methoxy -2,3-cycloligna-1,4-dien-2*a*,3*a*-olide [Vitexdoin G] 	*V. negundo*	Aerial parts/EtOH-H_2O (7:3, v/v) extract, EtOAc fraction		(Nie et al., 2016)
387	Cannabilignin 	*V. negundo*	Leaves/95% EtOH extract		(Li et al., 2016)
388	Isocannabilignin 	*V. negundo*	Leaves/95% EtOH extract		(Li et al., 2016)
389	9*R*-Hydroxy-*d*-sesamin 	*V. negundo*	Leaves/95% EtOH extract	Weak nitric oxide production inhibitory activity in lipopolysaccharide stimulated BV-2 microglial cells with IC_{50} value of 69.1 ± 5.8 μM.	(Li et al., 2016)
390	*cis*-Dihydro-dehydro-diconiferyl alcohol-9-*O*-*β*-D-glucoside 	*V. agnus-castus*	Fruit/hexane and MeOH extract		(S. Li et al., 2013)
391	(+)-Diasyringaresinol 	*V. negundo*	Roots/MeOH extract		(Haq et al., 2004)
392	Vitedoamine B 	*V. negundo*	Seeds/80% EtOH extract, DCM fraction	Inhibitory activities on LPS-induced nitric oxide (NO) production in RAW264.7 cells with IC_{50} value 0.87 μM.	(Zheng, Huang, et al., 2009)

(Continues)

TABLE 5 (Continued)

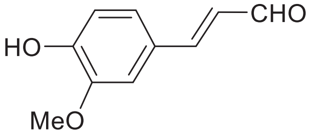
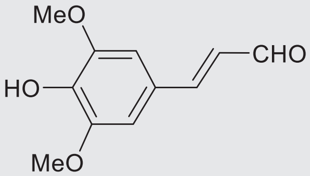
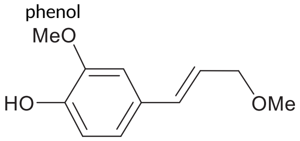
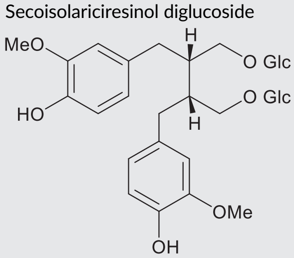
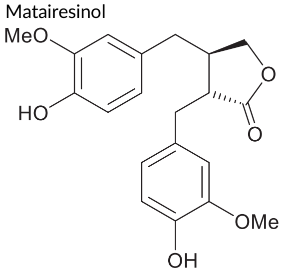
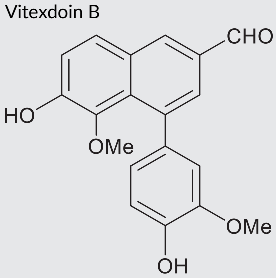
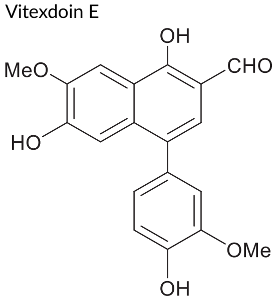
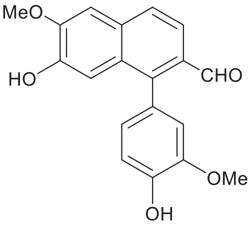
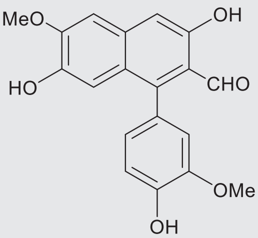
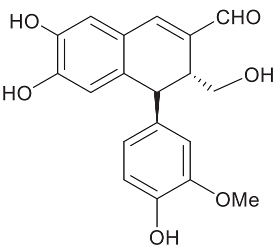
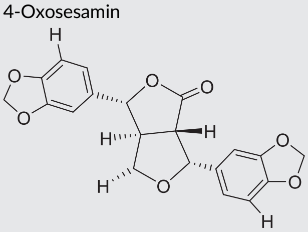
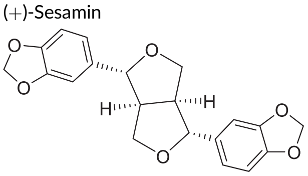
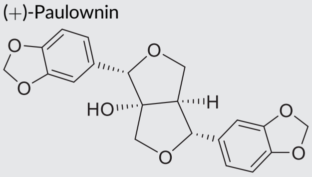
Compound No.	Compound name	Plant source	Plant parts/ fraction	Biological activity	References
393	Coniferyl aldehyde 	*V. negundo*	Fruits		(Zhao et al., 2012)
		V. rotundifolia	Fruit/EtOH extract, EtOAc fraction		(Wu et al., 2010)
394	*Trans*-3,5-dimethoxy-4-hydroxy-cinnamic aldehyde 	*V. negundo*	Seeds		(Zhao et al., 2012)
395	2-Methoxy-4-(3-methoxy-1-propenyl)-phenol 	*V. negundo*	Seeds		(Zhao et al., 2012)
396	Secoisolariciresinol diglucoside 	*V. negundo*	Seeds		(Zhao et al., 2012)
397	Matairesinol 	*V. negundo*	Seeds		(Zhao et al., 2012)
398	Vitexdoin B 	*V. negundo*	Seeds/80% EtOH, DCM fraction	Strong inhibitory activities on LPS-induced nitric oxide (NO) production in RAW264.7 cells with IC_{50} value 0.20 μM.	(Zheng, Huang, et al., 2009)
399	Vitexdoin E 	*V. negundo*	Seeds/80% EtOH extract, DCM fraction	Strong inhibitory activities on LPS-induced nitric oxide (NO) production in RAW264.7 cells with IC_{50} value 0.15 μM.	(Zheng, Huang, et al., 2009)

TABLE 5 (Continued)

Compound No.	Compound name	Plant source	Plant parts/ fraction	Biological activity	References
400	Vitexdoin C 	*V. negundo*	Seeds/80% EtOH extract, DCM fraction	Inhibitory activities on LPS-induced nitric oxide (NO) production in RAW264.7 cells with IC_{50} value 0.57 μM.	(Zheng, Huang, et al., 2009)
401	Vitexdoin D 	*V. negundo*	Seeds/80% EtOH extract, DCM fraction	Strong inhibitory activities on LPS-induced nitric oxide (NO) production in RAW264.7 cells with IC_{50} value 0.13 μM.	(Zheng, Huang, et al., 2009)
402	Vitexdoin A 	*V. negundo*	Seeds/80% EtOH extract, DCM fraction	Strong inhibitory activities on LPS-induced nitric oxide (NO) production in RAW264.7 cells with IC_{50} value 0.38 μM.	(Zheng, Huang, et al., 2009)
			Seeds/95% EtOH extract, EtOAc fraction	Inhibitory effect on nitric oxide (NO) production in murine microglial BV-2 cell line by the Griess reaction with IC_{50} value >30 μM and significant ABTS radical scavenging activity (IC_{50} value 1.43 ± 0.03 μM).	(Hu et al., 2016)
		V. cannabifolia	Aerial part/EtOH-H_2O (7:3, v/v) extract		(Nie et al., 2016)
			Fruit/MeOH, EtOAc fraction		(Fang et al. 2016b)
403	4-Oxosesamin 	*V. negundo*	Seeds/80% EtOH (v/v) extract, DCM fraction	Aantifungal activity against *Candida albicans* (MIC 64 μg/ml), *Cryptococcus neoformans* (MIC 16 μg/ml), *and Trichophyton rubrum* (MIC 64 μg/ml) by serial dilution method.	(Zheng et al., 2011)
404	(+)-Sesamin 	*V. negundo*	Seeds/80% EtOH (v/v) extract, DCM fraction		(Zheng et al., 2011)
405	(+)-Paulownin 	*V. negundo*	Seeds/80% EtOH (v/v) extract, DCM fraction		(Zheng et al., 2011)
			Fruits/40% EtOH extract	Cytotoxic effects against A-549 cell line with IC_{50} value 22.6 μM.	(Huang, Qing, et al., 2013)
			Fruits/MeOH extract, EtOAC fraction		(Fang et al. 2016b)

(Continues)

TABLE 5 (Continued)

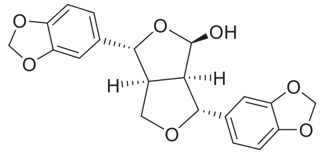
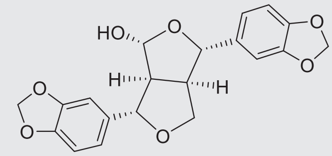
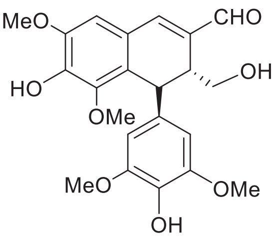
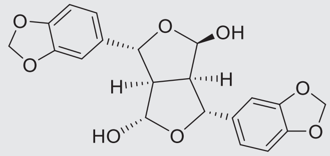
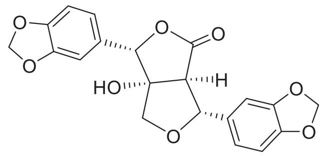
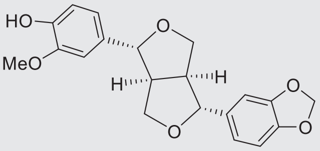
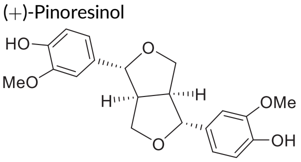
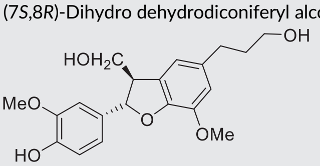
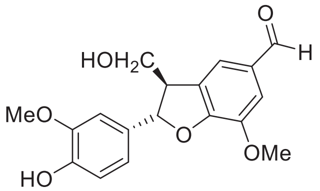
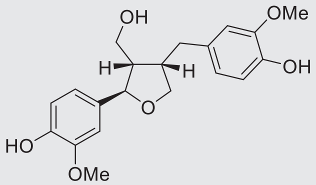
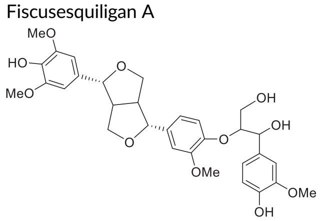
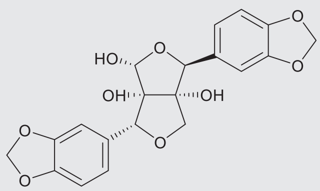
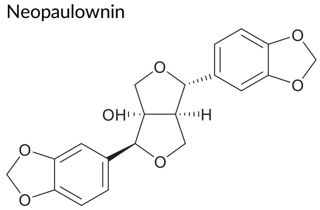
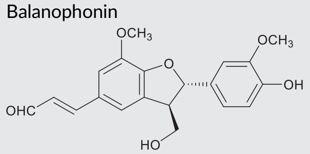
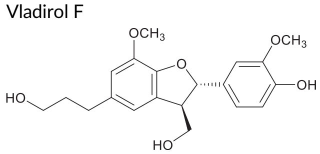
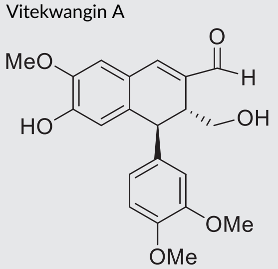
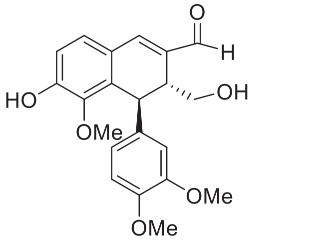
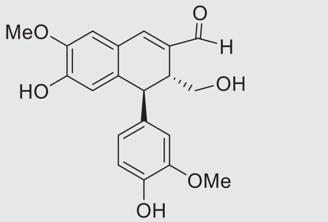
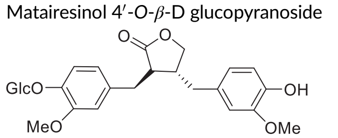
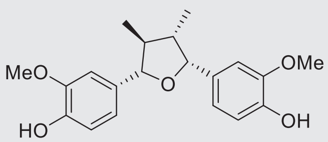
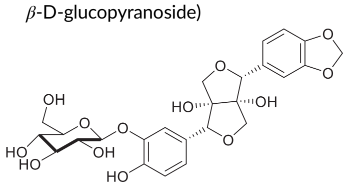
Compound No.	Compound name	Plant source	Plant parts/ fraction	Biological activity	References
406	4-Hydroxysesamin 	*V. negundo*	Seeds/80% EtOH extract		(Zheng et al., 2011)
407	9-Hydroxysesamin 	*V. negundo*	Seeds/80% EtOH extract		(Hu et al., 2016)
408	Ovafolinin E 	*V. negundo*	Aerial part/EtOH-H_2O (7:3, v/v) extract		(Nie et al., 2016)
409	4,8-Dihydroxysesamin 	*V. negundo*	Seeds/80% EtOH Extract		(Zheng et al., 2011)
410	4-Oxopaulownin 	*V. negundo*	Seeds/80% EtOH extract	Antifungal activity against *Candida albicans* (MIC 32 μg/ml), *Cryptococcus neoformans* (MIC 32 μg/ml), and *Trichophyton rubrum* (MIC 64 μg/ml) by serial dilution method.	(Zheng et al., 2011)
411	(+)-2-(3-Methoxy-4-hydroxy phenyl)-6-(3,4-methylenedioxy) phenyl-3,7-dioxabicyclo[3,3,0] octane 	*V. negundo*	Seeds/80% EtOH extract		(Zheng et al., 2011)
412	(+)-Pinoresinol 	*V. negundo*	Seeds/80% EtOH extract		(Zheng et al., 2011)
413	(7*S*,8*R*)-Dihydro dehydrodiconiferyl alcohol 	*V. rotundifolia*	Fruit/CH_2Cl_2 soluble fraction of MeOH extract	Weak inhibitory activities on LPS-induced NO production in RAW264.7 cells with IC_{50} value 38.7 μM.	(C. Lee et al., 2013)
		V. negundo	Aerial part/EtOH-H_2O (7:3, v/v) extract		(Nie et al., 2016)

TABLE 5 (Continued)

Compound No.	Compound name	Plant source	Plant parts/ fraction	Biological activity	References
414	Ficusal 	*V. rotundifolia*	Fruit/CH_2Cl_2 soluble fraction of MeOH extract		(C. Lee et al., 2013)
		V. agnus-castus	Fruit/MeOH		(S.-N. Chen et al., 2011)
415	(+)-Lariciresinol 	*V. rotundifolia*	Fruit/CH_2Cl_2 soluble fraction of MeOH extract		(C. Lee et al., 2013)
416	Fiscusesquiligan A 	*V. rotundifolia*	Fruit/CH_2Cl_2 soluble fraction of MeOH extract		(C. Lee et al., 2013)
417	Vitexkarinol 	*V. leptobotrys*	Leaves and twigs/DCM extract		(Pan et al., 2014)
418	Neopaulownin 	*V. leptobotrys*	Leaves and twigs/DCM extract		(Pan et al., 2014)
419	Balanophonin 	*V. agnus-castus*	Fruit/MeOH extract		(S.-N. Chen et al., 2011)
420	Vladirol F 	*V. agnus-castus*	Fruit/MeOH extract		(S.-N. Chen et al., 2011)
421	Vitekwangin A 	*V. kwangsiensia*	Fruits/MeOH extract, $CHCl_3$ fraction		(Shen et al., 2019)

(Continues)

TABLE 5 (Continued)

Compound No.	Compound name	Plant source	Plant parts/ fraction	Biological activity	References
422	6-Hydroxy-4-(3,4-dimethoxyphenyl)-3-hydroxymethyl-5-methoxy-3,4-dihydro-2-napthaldehyde 	*V. kwangsiensia*	Fruits/MeOH extract, $CHCl_3$ fraction		(Shen et al., 2019)
423	6-Hydroxy-4-(4-hydroxy-3-methoxyphenyl)-3-hydroxymethyl-7-methoxy-3,4-dihydro-2-naphthaldehyde 	*V. kwangsiensia*	Fruits/MeOH extract, $CHCl_3$ fraction		(Shen et al., 2019)
424	Matairesinol 4′-*O*-*β*-D glucopyranoside 	*V. trifolia*	Leaves/hot MeOH extract		(Ban et al., 2018)
425	Verrucosin 	*V. limonifolia*	Leaves/MeOH extract, DCM fraction Leaves/MeOH extract, DCM fraction		(Thoa, Ban, Trang, et al., 2018) (Ban et al., 2017)
426	Khainaoside A (3,4-methylenedioxyprinsepiol 3′-*O*-*β*-D-glucopyranoside) 	*V. glabrata*	Leaves/MeOH extract, H_2O fraction		(Luecha et al., 2009)

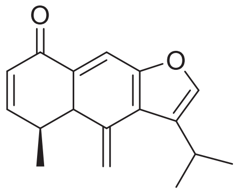
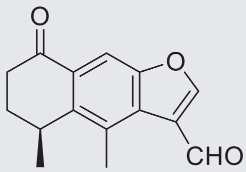
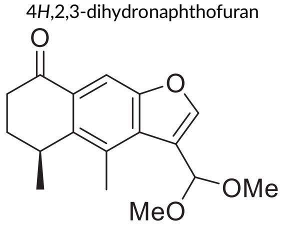
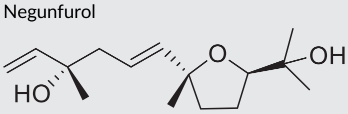
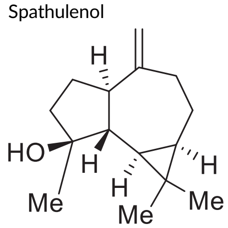
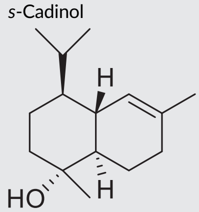
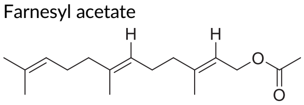
scavenging percentage ranging between 72 and 86%; moreover it showed a significant ferric ion reducing power (Ajiboye, 2015). Meanwhile, essential oil from, *V. agnus-castus* demonstrated a low antioxidant activity in the DPPH assay with IC_{50} of 1.072 mg/ml (Asdadi et al., 2015). Antioxidant properties were also reported for *V. mollis* Kunth methanolic extract using $ABTS^{+}$ and $DPPH^{+}$ radicals. Al-Wajeeh, Halabi, Hajrezaie, et al. (2016) investigated *V. pubescens* Vahl leaf extract and found a potent reduction of ferric with high FRAP value at 723.0 ± 0.03 μmol Fe (II)/g and DPPH IC_{50} value of 38.3 ± 0.1 μg/ml.

Methanolic crude extract of *V. negundo* showed good antiradical scavenging activity of 87.02 ± 0.215% as quantified by the DPPH method (Prakash et al., 2016).

A lot of compounds and various extracts from different parts of *V. doniana*, *V. agnus-castus*, *V. pubescens*, *V. altissima*, *V. negundo*, and *V. mollis* were reported for their antioxidant activity on the DPPH radical, superoxide ion, hydrogen peroxide, and hydroxyl radical.

Among different chemical classes of compounds were reported from *Vitex* for their antioxident activity, flavonoids and lignans are the major ones. These two classes of compounds from *Vitex* were reported to have their anticancer activity also. Specially, a lignin, 6-hydroxy-4-(4-hydroxy-3-methoxyphenyl)-3-hydroxymethyl-7-methoxy-3,4-dihydro-2-naphthal dehyde, from *Vitex* which is reported here to have both of its antioxidant and anticancer activity. But, natural antioxidants were already reported for their role in cancer (Asadi-Samani, Farkhad, Mahmoudian-Sani, & Shirzad, 2019; Valadez-Vega et al., 2013). Based on this correlation, we

TABLE 6 List of sesquiterpenoids reported from different species of *Vitex* and their biological activities

Compound No.	Compound name	Plant source	Plant parts/extraction solvent/fraction	Biological activity	References
427	1,6-Dioxo-2(3),9(10)-dehydrofuranoeremophilane 	*V. negundo*	Stem bark/MeOH extract, hexane fraction		(Tiwari, Yadav, Vasudev, et al., 2013)
428	4,6-Dimethyl-11-dimethoxymethyl-1-*oxo*-4*H*,2,3-dihydronapthofuran 	*V. negundo*	Stem bark/MeOH extract, hexane fraction		(Tiwari, Yadav, et al., 2013)
429	4,6-dimethyl-11-formyl-1-*oxo*-4*H*,2,3-dihydronaphthofuran 	*V. negundo*	Stem bark/MeOH extract, hexane fraction		(Tiwari, Yadav, et al., 2013)
430	Negunfurol 	*V. negundo*	Seeds/80% ethanol extract	Cytotoxicity against human colon carcinoma (HCT116) cell line with IC_{50} value 8.11 ± 1.40 μg/ml; blood cancer (HL-60) cell line with IC_{50} value 0.94 ± 0.26 μg/ml; and breast carcinoma (ZR-75-30) cell line having IC_{50} 13.18 ± 3.05 μg/ml	(Zheng, Pu, et al., 2012)
431	Spathulenol 	*V. agnus-castus*	Fruit/n-hexane		(S. Li et al., 2013)
			Seed essential oil		(Asdadi et al., 2015)
		V. poligama	Leaves		(Barbosa, Demuner, Howarth, et al., 1995)
432	*s*-Cadinol 	*V. agnus-castus*	Seed essential oil		(Asdadi et al., 2015)
433	Farnesyl acetate 	*V. agnus-castus*	Seed essential oil		(Asdadi et al., 2015)

(Continues)

TABLE 6 (Continued)

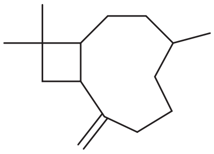
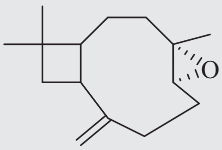
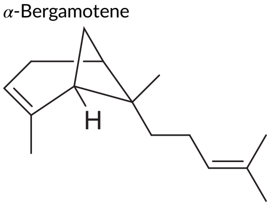
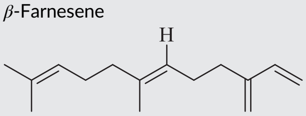
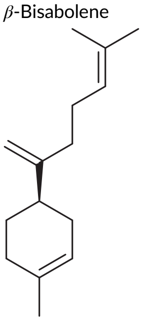
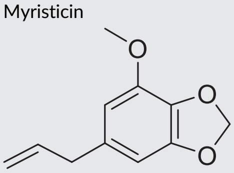
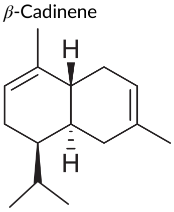
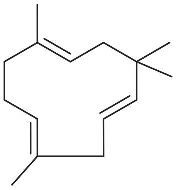
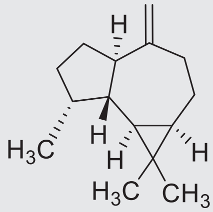
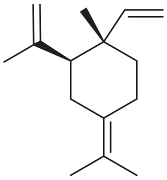
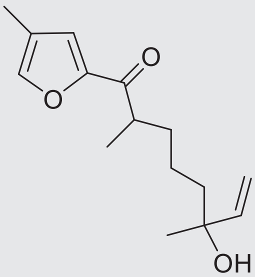
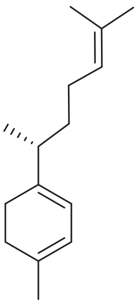
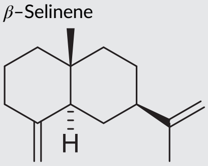
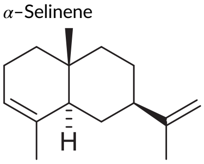
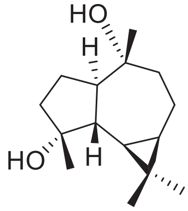
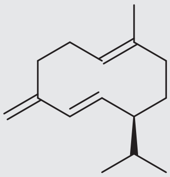
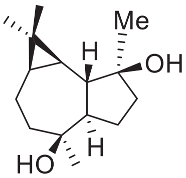
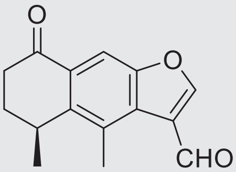
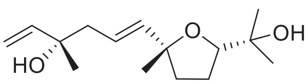
Compound No.	Compound name	Plant source	Plant parts/extraction solvent/fraction	Biological activity	References
434	β–Caryophyllene 	*V. negundo*	Volatile constituents of leaves		(Singh, Dayal, & Bartley, 1999)
		V. agnus-castus	Seed essential oils		(Asdadi et al., 2015)
			Leaves essential oil		(Khalilzadeh, Saiah, Hasannejad, et al., 2015)
			Seed, leaves, and flowers essential oil		(Neves & Da Camara, 2016)
		V. rivularis	Aerial parts of essential oil		(Cabral, Gonçalves, Cavaleiro, et al., 2009)
		V. quinata	Leaves essential oil		(Dai, Thang, Ogunwande, et al., 2015)
435	β-Caryophylleneoxide 	*V. negundo*	Leaves/diethylether		(Singh et al., 1999)
		V. agnus-castus	Seed essential oil		(Asdadi et al., 2015)
436	α-Bergamotene 	*V. agnus-castus*	Seed essential oil		(Asdadi et al., 2015)
437	β-Farnesene 	*V. agnus-castus*	Seed, leaves, fruit, flower essential oil		(Asdadi et al., 2015); (Khalilzadeh et al., 2015); (Neves & Da Camara, 2016)
438	β-Bisabolene 	*V. agnus-castus*	Seed essential oil		(Asdadi et al., 2015)
439	Myristicin 	*V. agnus-castus*	Seed essential oil		(Asdadi et al., 2015)
440	β-Cadinene 	*V. agnus-castus*	Seed essential oil		(Asdadi et al., 2015)

TABLE 6 (Continued)

Compound No.	Compound name	Plant source	Plant parts/extraction solvent/fraction	Biological activity	References
441	α-Humulene 	*V. agnus-castus*	Seed essential oil		(Asdadi et al., 2015)
442	Aromadendrene 	*V. agnus-castus* *V. negundo*	Seed essential oil Leaves volatile constituents		(Asdadi et al., 2015) (Singh et al., 1999)
443	γ-Elemene 	*V. agnus-castus*	Seed essential oil		(Asdadi et al., 2015)
444	Vemopolyantho furan 	*V. leptobotrys*	Leaves and twigs/DCM fraction		(Pan et al., 2014)
445	γ-Curcumene 	*V. rivularis*	Aerial parts essential oils		(Cabral et al., 2009)
446	β–Selinene 	*V. negundo*	Fruit oil		(Khokra, Prakash, Jain, et al., 2008)
447	α–Selinene 	*V. negundo*	Flower oil		(Khokra et al., 2008)

(Continues)

TABLE 6 (Continued)

Compound No.	Compound name	Plant source	Plant parts/extraction solvent/fraction	Biological activity	References
448	4α,10α–Dihydroxyaromadendrane 	*V. agnus-castus*	Fruit/Acetone Fruit/defatted MeOH extract		(Ono et al., 2011) (S.-N. Chen et al., 2011)
449	Germacrene D 	*V. rivularis*	Aerial parts essential oil		(Cabral et al., 2009)
450	4β,10β-Dihydroxyaromadendrane 	*V. agnus-castus*	Fruit/hexane extract		(Ono et al., 2009)
451	3-Formyl-4,5-dimethyl-8-*oxo*-5*H*-6,7-dihydronaphtho[2,3-*b*]furan 	*V. negundo*	Seeds/hot aqueous ethanol (80% v/v), CH_2Cl_2 extract	Evaluated *in-vitro* cytotoxicity against human lung carcinoma (A549) cell line having IC_{50} value >100 μg/ml; colon carcinoma (HCT116) cell line having IC_{50} value >100 μg/ml; blood cancer (HL-60) cell line having IC_{50} value 29.15±2.37 μg/ml; and breast carcinoma (ZR-75-30) cell line having IC_{50}, >100 μg/ml	(Zheng, Pu, et al., 2012)
452	Schensianol A 	*V. kwangsiensia*	Fruits/MeOH extract, $CHCl_3$ fraction		(Shen et al., 2019), (Zheng, Pu, et al., 2012)

are very much optimistitic that *Vitex* will bring a novel lead for the treatmt of cancer in near future.

5.1.5 | Antiviral activity

According to (Tietjen, Gatonye, Ngwenya, et al., 2016), organic extract obtained from *V. doniana* L. inhibited HIV-1 replication *in-vitro* at 25 μg/ml.

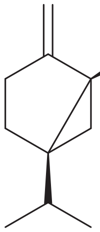
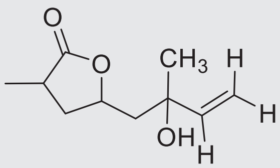
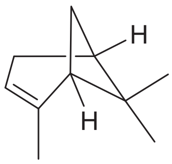
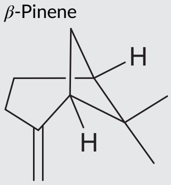
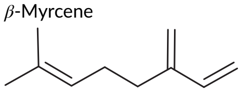
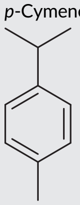
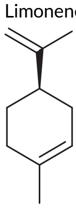
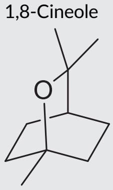
5.1.6 | Trypanocidal activity

Six diterpenoids, two nor-diterpene aldehydes 1 and 2 (**90** and **91**), vitexifolins E (**74**) and F (**75**), vitexilactone (**42**), and 6-acetoxy-9-hydroxy-13(14)-labden-16,15-olide (**38**) isolated from the fruits of *V. trifolia* showed significant *in-vitro* trypanocidal activity against epimastigotes of *Trypanosoma cruzi* with MLCs of 11, 36, 34, 34, 66, and 66 μM, respectively (Kiuchi et al., 2004; Wu et al., 2009).

5.1.7 | Antimutagenic activity

(+)-Polyalthic acid (**46**) isolated from MeOH extract of *V. rotundiforia* whole plant exhibited antimutagenic activity by suppressing the mutagenicity of Trp P-1 (3-amino-1,4-dimethyl-5H-pyrido [4,3b] indole) in Umu gene expression assay with ID_{50} value of 0.29 μM/ml (Miyazawa et al., 1995).

TABLE 7 List of monoterpenoids reported from different species of *Vitex* and their biological activities

Compound No.	Compound name	Plant source	Plant parts/extraction solvent/fraction	Biological activity	References
453	Sabinene 	*V. negundo*	Leaves/diethyl ether		(Singh et al., 1999)
454	Vitexoid 	*V. trifolia*	Fruits/H_2O:acetone -7:3 (v/v) extract, $CHCl_3$ fraction	Antiproliferative activity against HeLa cells with IC_{50} value 26.6 ± 1.8 μMol/L.	(J. Wu et al., 2009)
455	α-Pinene 	*V. agnus-castus*	Seed essential oil		(Asdadi et al., 2015)
		V. negundo	Essential oil		(Khalilzadeh et al., 2015)
		V. pseudo-negundo	Leaves/ Essential oil		(Singh et al., 1999)
			Essential oil		(Borzoui, Naseri, Abedi, & Karimi-Pormehr, 2016)
456	β-Pinene 	*V. agnus-castus*	Seed essential oil		(Asdadi et al., 2015)
		V. negundo	Leaves Essential oil		(Singh et al., 1999)
		V. quinata	Leaves Essential oil		(Dai et al., 2015)
457	β-Myrcene 	*V. agnus-castus*	Seed essential oil		(Asdadi et al., 2015)
458	*p*-Cymene 	*V. agnus-castus*	Seed essential oil		(Asdadi et al., 2015)
		V. negundo	Leaves Essential oil		(Singh et al., 1999)
459	Limonene 	*V. agnus-castus*	Seed essential oil		(Asdadi et al., 2015)
			Essential oils		(Khalilzadeh et al., 2015)
		V. negundo	Leave, Essential oil		(Singh et al., 1999)
460	1,8-Cineole 	*V. agnus-castus*	Seed essential oil		(Asdadi et al., 2015)
			Leaves, fruit, and flower essential oil		(Neves & Da Camara, 2016)
		V. pseudo-negundo	Essential oil		(Borzoui et al., 2016)

(Continues)

TABLE 7 (Continued)

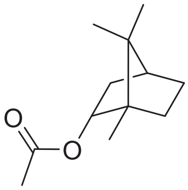
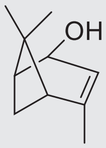
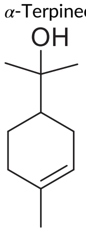
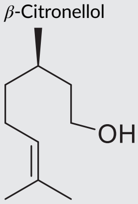
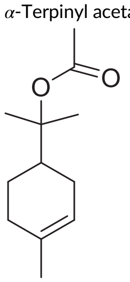
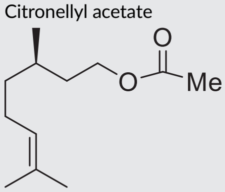
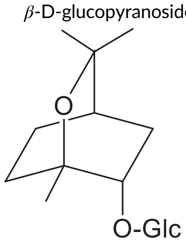
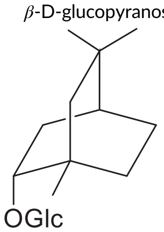
Compound No.	Compound name	Plant source	Plant parts/extraction solvent/fraction	Biological activity	References
461	Bornyl acetate 	*V. agnus-castus*	Seed essential oil		(Asdadi et al., 2015)
462	Verbenol 	*V. agnus-castus*	Seed essential oil		(Asdadi et al., 2015)
463	α-Terpineol 	V. agnus-castus	Seed essential oil		(Asdadi et al., 2015)
		V. negundo	Leave volatile constituents		(Singh et al., 1999)
464	β-Citronellol 	*V. agnus-castus*	Seed essential oil		(Asdadi et al., 2015)
465	α-Terpinyl acetate 	*V. agnus-castus*	Seed essential oil		(Asdadi et al., 2015)
466	Citronellyl acetate 	*V. agnus-castus*	Seed essential oil		(Asdadi et al., 2015)
467	(1*S*,2*S*,4*R*)-2-*endo*-Hydroxy-1,8-cineole β-D-glucopyranoside 	*V. rotundifolia*	Fruit/EtOH extract, EtOAc fraction		(Wu et al., 2010)

TABLE 7 (Continued)

Compound No.	Compound name	Plant source	Plant parts/extraction solvent/fraction	Biological activity	References
468	(1*R*,2*R*,4*S*)-2-*endo*-Hydroxy-1,8-cineole β-D-glucopyranoside 	*V. rotundifolia*	Fruit/EtOH extract, EtOAc fraction		(Wu et al., 2010)

5.1.8 | Antiosteoporotic activity

The lignan vitexdoin F (**358**) isolated from *V. negundo* seeds showed potent antiosteoporotic effect by inhibiting the proliferation and ALP activity of osteoblastic UMR106 cells at 10^{-7}M concentration (C.-J. Zheng et al., 2014).

5.1.9 | Vasorelaxant activity

The CH_2Cl_2-MeOH (1:1) extract of *V. cienkowskii* stem bark showed significant endothelium-dependent vasorelaxant activity with EC_{50} value of 12.12 μg/ml in isolated rat aortic rings precontracted with noradrenaline (1 μM). The isolated compounds, mixture of salvin A and maslinic acid, tanacetamide, and β-sitosterol glycoside from this bioactive fraction showed vasorelaxant effect in the same model with EC_{50} values of 1.999, 4.256, and 1.178 mg/L, respectively (Dongmo et al., 2011).

Tetra-acetylajugasterone C (**470**) isolated from *V. cienkowskii* stem bark produced strong vasorelaxant activity in a concentration-dependent manner in rat artery rings precontracted with 1 μM noradrenalin or 60 mM KCl with IC_{50} values of 8.40 and 36.30 μM, respectively (Dongmo et al., 2014).

5.2 | In-vivo experiments

5.2.1 | Anti-inflammatory activity

The EtOH extract of *Vitex glabrata* leaves exhibited significant anti-inflammatory activity in carrageenan-induced paw edema and cotton pellet-induced granuloma formation in rat models. The extract showed significant anti-inflammatory activity in rats at a dose of 400 mg/kg bw, *p.o.*, and the activity was comparable to that of standard reference drug, diclofenac sodium (50 mg/kg *p.o.*) (Chouhan, Sridevi, Singh, & Singh, 2012). The EtOAc extract of *Vitex altissima* L. leaves also exhibited significant anti-inflammatory activity in rat paw edema model (Sridhar et al., 2004). The $CHCl_3$, EtOAc, and *n*-BuOH fractions from methanolic extract of the stem-bark of *V. doniana* Sweet exhibited significant anti-inflammatory activity on carrageenan-induced paw edema model in rats at a dose of 100 mg/kg bw, *p.o.* by inhibiting the paw edema volume by 68–72%, which effects were comparable to that of the reference drug, diclofenac (50 mg/kg *p.o.*), which was including having 81.94% inhibition. Seven ecdysteroids namely 21-hydroxyshidasterone (**478**), 11β-hydroxy-20-deoxyshidasterone (**491**), 24-hydroxy ecdysone (**488**), 24-hydroxyecdysone-2,3-acetonide (**487**), shidasterone (**477**), ajugasterone C (**469**), and 11β, 24-dihydroxy ecdysone (**489**) isolated from these fractions showed significant (p < .05) inhibitory effect (58–71% inhibition after 6 hr) at 100 mg/kg, *p.o.* on rat paw edema development. The reference drug, diclofenac sodium, showed 70% inhibition after 6 hr (Ochieng et al., 2013).

Casticin (**292**) also protected against lipopolysaccharide (LPS)-induced acute lung injury in mice by inhibiting inflammatory cytokines production through the inhibition of NF-κB and NLRP3 signaling pathways (Wang, Zeng, Zhang, et al., 2016).

The $CHCl_3$ extract of *V. negundo* seeds exhibited anti-inflammatory activity in carrageenan-induced rat paw edema model. The extract at a dose of 500 mg/kg bw, *p.o.* showed 34.8% inhibition of paw edema volume after 3.5 hr of injection of carrageenan. The isolated triterpenoid, 2α,3α-dihydroxyoleana-5, 12-dien-28-oic acid (**203**) showed weak inhibition (18.7%) of paw edema volume at a dose of 50 mg/kg *p.o.* The standard drug, ibuprofen (50mg/kg, *p.o.),* showed 63.2% inhibition of paw edema volume (Chawla, Sharma, Handa, & Dhar, 1992).

The EtOAc extract and its isolate, 6′-*O*-*trans*-feruloylnegundoside (**13**) from *V. altissima* leaves exhibited moderate anti-inflammatory activity in the carrageenan-induced rat paw edema model by inhibiting 39 and 20% of the paw edema volume at a dose of 250 and 200 mg/kg after 3 hr, respectively (Sridhar et al., 2004).

Ethanolic crude extract from *V. megapotamica* presented anti-inflammatory effects in complete Freund's adjuvant (CFA)-induced chronic inflammation model at 10 mg/kg, without altering locomotor activity (Hamann, Zago, Rossato, et al., 2016). However, agnuside, an iridoid compound isolated from *V. mollis* Kunth, did not exhibit inhibitory activity against COX-1 and COX-2 *in-vitro* model (Ramírez-Cisneros et al., 2015). On the other hand, phenol glucoside 4-hydroxyphenethanol-3-*O*-β-D-(6′-*O*-*p*-hydroxy benzoyl)-glucopyranoside (**517**) isolated from

TABLE 8 List of ecdysteroids reported from different species of *Vitex* and their biological activities

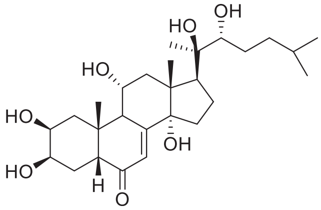
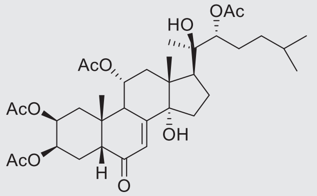
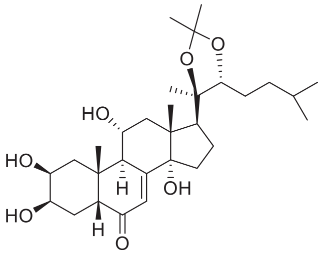
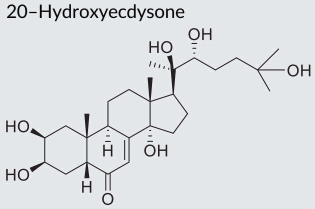
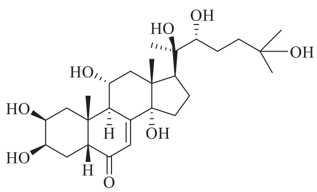
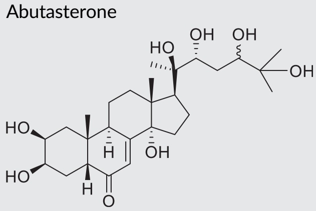
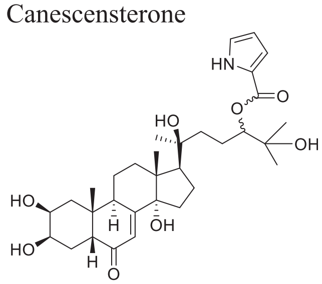
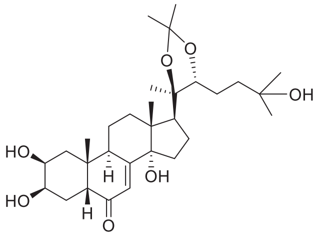
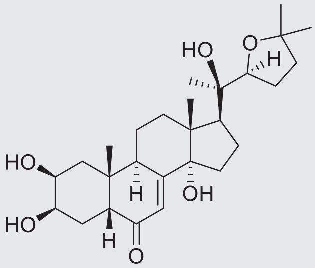
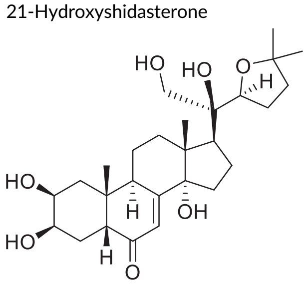
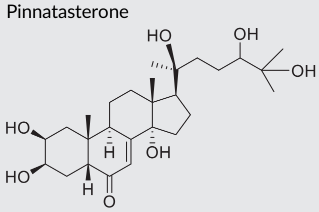
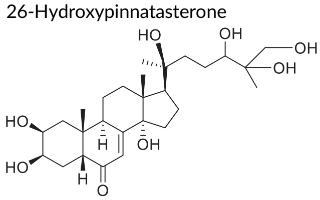
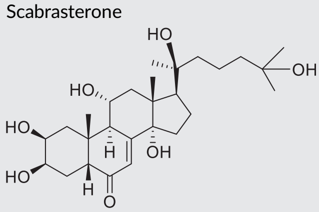
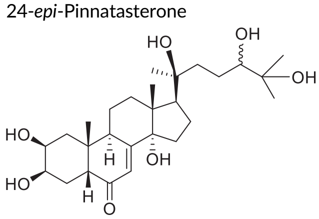
Compound No.	Compound name	Plant source	Plant parts/extraction solvent/fraction	Biological activity	References
469	Ajugasterone C 	*V. polygama*	Stem barks/EtOH extra		(dos Santos, Delle Monache, & Leitão, 2001)
		V. strickeri	Root bark/MeOH extract		(Zhang, Stout, & Kubo, 1992)
		V. doniana	Stem bark/MeOH, EtOAc and *n*-BuOH fraction	Significant *in vivo* antiinflammatory activity.	(Ochieng, Ishola, Opiyo, et al., 2013)
		V. scabra	Stem bark/MeOH extract, *n*-BuOH fraction		(Suksamrarn, Kumpun, & Yingyongnarongkul, 2002b)
470	Tetra-acetylajugasterone C 	*V. cienkowskii*	Stem bark/DCM-MeOH and MeOH fraction	Vasorelaxant activity	(Dongmo, Nkeng-Efouet, Devkota, et al., 2014)
471	Ajugasterone C-20,22- monoacetonide 	*V. polygama*	Branches/EtOH extract		(dos Santos et al., 2001)
		V. strickeri	Root bark/MeOH extract		(Zhang, Stout, & Kubo, 1992)
472	20–Hydroxyecdysone 	*V. cymosa*	Stem bark/EtOH extract, DCM fraction		(dos Santos et al., 2001)
		V. strickeri	Root bark/ MeOH extract		(Zhang et al., 1992)
		V. scabra	Stem bark/MeOH extract, *n*-BuOH fraction		(Suksamrarn, Kumpun, & Yingyongnarongkul, 2002b)
		V. canescens	Bark/EtOH		(Apichart Suksamrarn, Sommechai, Charulpong, & Chitkul, 1995)
473	Turkesterone 	*V. polygama*	Branches/EtOH extract		(dos Santos et al., 2001)
		V. scabra	Stem bark/MeOH extract, *n*-BuOH fraction		(Suksamrarn, Kumpun, & Yingyongnarongkul, 2002b)
		V. canescens	Bark/EtOH extract		(Suksamrarn et al., 1995)
474	Abutasterone 	*V. strickeri*	Root bark/ MeOH extract		(Zhang et al., 1992))
475	Canescensterone Canescensterone 	*V. canescens*	Bark/EtOH extract		(Suksamrarn et al., 1995)

TABLE 8 (Continued)

Compound No.	Compound name	Plant source	Plant parts/extraction solvent/fraction	Biological activity	References
476	20-Hydroxyecdysone-20,22-monoacetonide 	*V. strickeri*	Root bark/MeOH extract		(Zhang et al., 1992))
477	Shidasterone 	*V. doniana*	Stem bark/MeOH extract, $CHCl_3$ fraction	Antiinflammatory activity.	(Ochieng et al., 2013)
478	21-Hydroxyshidasterone 	*V. doniana*	Stem bark/MeOH extract, EtOAc fraction	Antiinflammatory activity.	(Ochieng et al., 2013)
479	Pinnatasterone 	*V. scabra* *V. pinnata*	Stem barkMeOH extract, *n*-BuOH fraction Bark/EtOH extract		(Suksamrarn, Kumpun, & Yingyongnarongkul, 2002b) (Apichart Suksamrarn & Sommechai, 1993)
480	26-Hydroxypinnatasterone 	*V. cymosa*	Stem bark/ EtOH extract, DCM fraction		(dos Santos et al., 2001)
481	Scabrasterone 	*V. scabra*	Stem bark/MeOH extract, *n*-BuOH fraction		(Suksamrarn, Kumpun, & Yingyongnarongkul, 2002b)
482	24-*epi*-Pinnatasterone 	*V. scabra*	Stem bark/MeOH extract, *n*-BuOH fraction		(Suksamrarn, Kumpun, & Yingyongnarongkul, 2002b)

(Continues)

TABLE 8 (Continued)

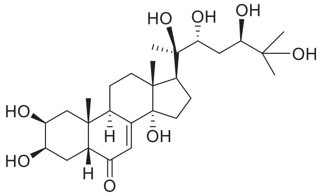
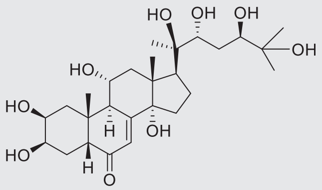
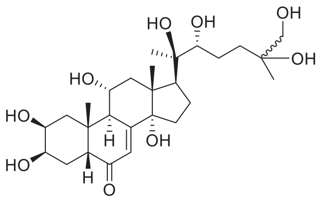
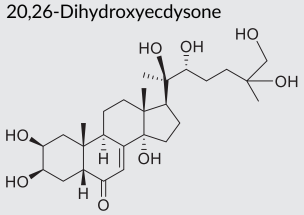
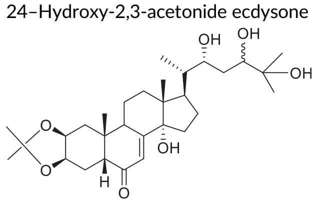
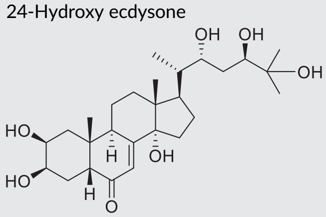
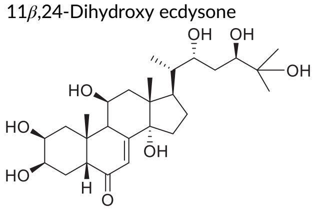
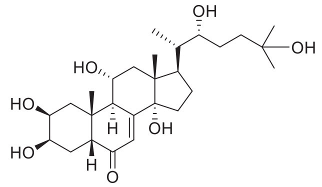
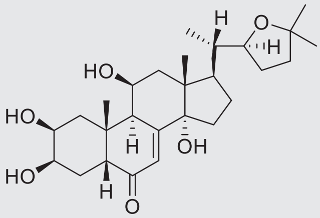
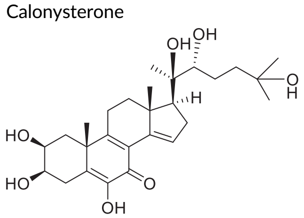
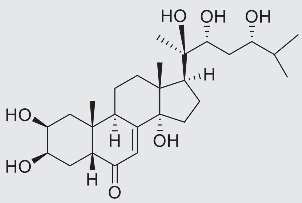
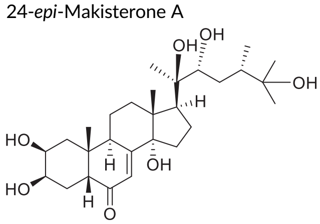
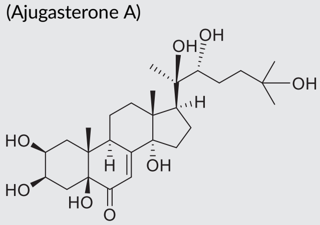
Compound No.	Compound name	Plant source	Plant parts/extraction solvent/fraction	Biological activity	References
483	24-*epi*-Abutasterone 	*V. scabra*	Stem bark/MeOH extract, *n*-BuOH fraction		(Suksamrarn, Kumpun, & Yingyongnarongkul, 2002b)
484	(24*R*)-11α,20,24-Trihydroxy-ecdysone 	*V. canescens*	Root bark/EtOH extract, *n*-BuOH fraction		(A Suksamrarn, Promrangsan, & Jintasirikul, 2000)
485	11α, 20, 26-Trihydroxy--ecdysone and its C-25 epimer 	*V. canescens*	Root bark/EtOH extract, *n*-BuOH fraction		(A Suksamrarn et al., 2000)
486	20,26-Dihydroxyecdysone 	*V. scabra*	Stem bark/ MeOH extract, *n*-BuOH fraction		(Suksamrarn, Kumpun, & Yingyongnarongkul, 2002b)
487	24–Hydroxy-2,3-acetonide ecdysone 	*V. doniana*	Stem bark/ MeOH extract, EtOAc fraction	Antiinflammatory activity.	(Ochieng et al., 2013)
488	24-Hydroxy ecdysone 	*V. doniana*	Stem bark/ MeOH extract, EtOAc fraction	Antiinflammatory activity.	(Ochieng et al., 2013)
489	11β,24-Dihydroxy ecdysone 	*V. doniana*	Stem bark/ MeOH extract, *n*-BuOH fraction	Antiinflammatory activity.	(Ochieng et al., 2013)

TABLE 8 (Continued)

Compound No.	Compound name	Plant source	Plant parts/extraction solvent/fraction	Biological activity	References
490	11α-Hydroxyecdysone 	*V. strickeri*	Root bark/MeOH extract		(Zhang et al., 1992)
		V. scabra	Stem bark/MeOH extract, *n*-BuOH fraction		(Suksamrarn, Kumpun, & Yingyongnarongkul, 2002b)
491	11β-Hydroxy-20-deoxyshidasterone 	*V. doniana*	Stem bark/ MeOH extract, EtOAc fraction	Antiinflammatory activity.	(Ochieng et al., 2013)
492	Calonysterone 	*V. scabra*	Stem bark/MeOH extract, *n*-BuOH fraction		(Suksamrarn, Kumpun, & Yingyongnarongkul, 2002b)
493	Pterosterone 	*V. scabra*	Stem bark/ MeOH extract, *n*-BuOH fraction		(Suksamrarn, Kumpun, & Yingyongnarongkul, 2002b)
494	24-*epi*-Makisterone A 	*V. scabra*	Stem bark/MeOH extract, *n*-BuOH fraction		(Suksamrarn, Kumpun, & Yingyongnarongkul, 2002b)
495	Polypodine B (Ajugasterone A) 	*V. scabra*	Stem bark/MeOH extract, *n*-BuOH fraction		(Suksamrarn, Kumpun, & Yingyongnarongkul, 2002b)

V. negundo L. var. *heterophylla* reduced 50% nitric oxide production on macrophage in concentrations at 30.76 μM (Qiu et al., 2017).

Different extracts and compounds from *V. doniana*, *V. altissima*, *V. glabrata*, *V. megapotamica*, *V. peduncularis*, *V. rotundifolia*, *V. negundo*, and *V. mollis* were reported for their anti-inflammatory activitiy *via* inhibition of NF-κB and NLRP3 signaling pathways, *via* inhibition of the levels of the inflammatory cytokines TNF-α, IL-6, and IL-1β production, *via* suppression of LPS induced NO formation, *via* inhibition of COX proteins and iNOS proteins, and *via* inhibition of p38, ERK1/2, and JNK pathways. Genus *Vitex* may be an important natural source for the development of novel anti-inflammatory molecule in future.

5.2.2 | Anticancer activity

Casticin (**292**) also inhibited tumor growth *in-vivo* experimented with xenografted tumors (Song et al., 2017). The antiproliferative activity of vitexicarpin (**292**) was also evaluated on *in-vivo* hollow

TABLE 9 List of other compounds reported from different species of *Vitex* and their biological activities

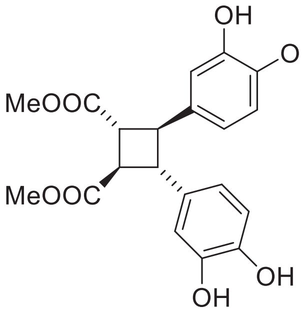
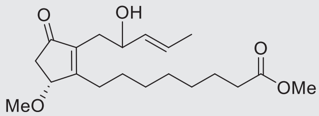
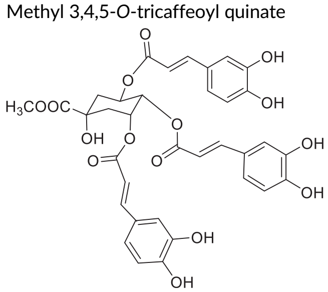
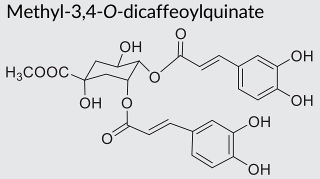
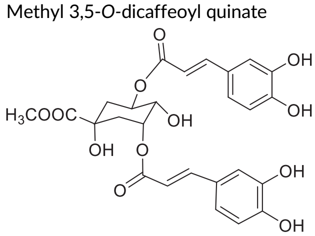
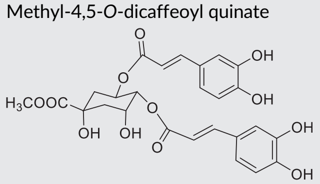
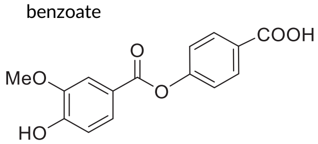
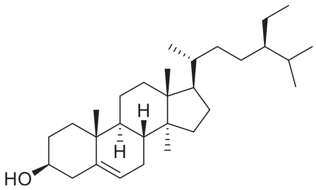
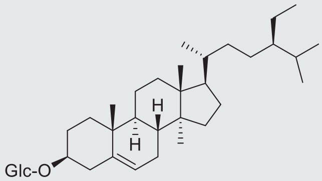
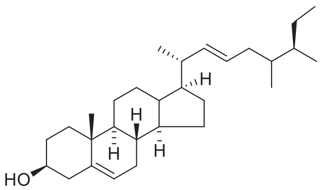
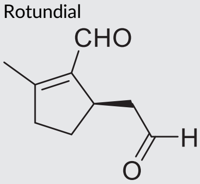
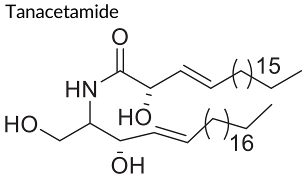
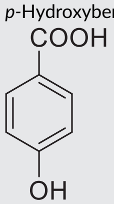
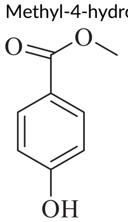
Compound No.	Compound name	Plant source	Plant parts/extraction solvent/fraction	Biological activity	References
496	Dimethyl 3,4,3′,4′-tetrahydroxy-δ- truxinate 	*V. quinata*	Leaves/MeOH extract, EtOAc fraction		(Deng et al., 2011)
497	Methyl 10*R*-methoxy-12-*oxo*-9(13), 16*E* – phytodienoate 	*V. quinata*	Leaves/MeOH extract, $CHCl_3$ fraction		(Deng et al., 2011)
498	Methyl 3,4,5-*O*-tricaffeoyl quinate 	*V. quinata*	Leaves/MeOH extract, $CHCl_3$ fraction		(Deng et al., 2011)
499	Methyl-3,4-*O*-dicaffeoylquinate 	*V. quinata*	Leaves/MeOH extract, $CHCl_3$ fraction		(Deng et al., 2011)
		V. polygama	Leaves/EtOH extract, EtOAc fraction		(Leitao, da Fonseca, dos Santos, et al., 2008)
500	Methyl 3,5-*O*-dicaffeoyl quinate 	*V. quinata*	Leaves/MeOH extract, $CHCl_3$ fraction		(Deng et al., 2011)
		V. polygama	Leaves/EtOH extract, EtOAc fraction		(Leitao et al., 2008)
		V. negundo	Leaves/ 95% EtOH extract, EtOAc fraction	Radical scavenging activity {DPPH assay (IC_{50}, 9.69 ± 0.18 μM) ABTS assay (IC_{50}, 1.75 ± 0.03 μM} and moderate α –glucosidase inhibitory effects (IC_{50}, 1.46 ± 0.04 μM).	(Hu et al., 2017)
501	Methyl-4,5-*O*-dicaffeoyl quinate 	*V. quinata*	Leaves/MeOH extract, $CHCl_3$ fraction		(Deng et al., 2011)
		V. negundo	Leaves/ 95% EtOH extract, EtOAc fraction	Radical scavenging activity {DPPH assay (IC_{50}, >100 μM) ABTS assay (IC_{50}, 46.30 ± 0.80 μM)} and weaker α –glucosidase inhibitory effects (IC_{50}, >100 μM)	(Hu et al., 2017)
502	4-Carboxyphenyl 4-hydroxy-3-methoxy benzoate 	*V. gardneriana*	Stem barks/EtOH extract		(Vale et al., 2017)

TABLE 9 (Continued)

Compound No.	Compound name	Plant source	Plant parts/extraction solvent/fraction	Biological activity	References
503	*β*-Sitosterol 	*V. negundo*	Leaves/MeOH		(Chandramu et al., 2003)
		V. pinnata	Leaves		(Kamal et al., 2011)
		V. agnus-castus	Seed essential oil		(Asdadi et al., 2015)
			Fruit/*n*-hexane extract		(S. Li et al., 2013)
		V. cienkowskii	Stem bark/DCM-MeOH		(Dongmo et al., 2011)
		V. trifolia	Leaves and twigs/MeOH		(Ming-Yu Huang et al., 2013)
504	*β*-Sitosterol glucoside 	*V. cienkowskii*	Stem bark/DCM-MeOH fraction	V	(Dongmo et al., 2011)
		V. trifolia	Leaves and Twigs /MeOH extract		(Ming-Yu Huang et al., 2013)
505	Stigmasterol 	*V. trifolia*	Leaves/EtOH extract, EtOAc fraction		(Mohamed et al., 2012)
506	Rotundial 	*V. rotundifolia*	Volatile constituents of fresh leaves	Mosquito repellent activity.	(Watanabe, Takada, Matsuo, & Nishimura, 1995)
507	Tanacetamide 	*V. cienkowskii*	Stem bark/DCM-MeOH and MeOH	Vasorelaxant activity	(Dongmo et al., 2011)
508	*p*-Hydroxybenzoic acid 	*V. negundo*	Leaves/MeOH		(Chandramu et al., 2003)
		V. pinnata	Leaves/MeOH extract, EtOAC fraction		(Rudrapaul et al., 2014)
		V. agnus-castus	Leaves, seeds, roots/70% MeOH-water		(Mingqing Huang et al., 2015)
		V. trifolia	Fruit/MeOH extract, EtOAc fraction		(S. Li et al., 2013)
			Leaves and Twigs/MeOH, EtOAc fraction		(Ming-Yu Huang et al., 2013)
		V. rotundifolia	Fruit/EtOH extract/ EtOAc fraction		(Wu et al., 2010)
		V. gardneriana	Stem barks/EtOH extract		(Vale et al., 2017)
509	Methyl-4-hydroxybenzoate 	*V. negundo*	Dried fruit/40% EtOH extract		(Huang, Qing, et al., 2013)

(Continues)

TABLE 9 (Continued)

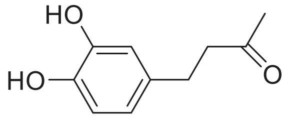
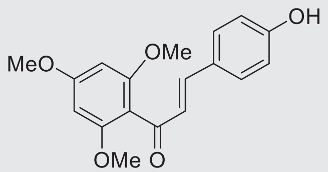
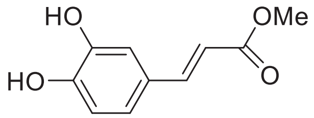
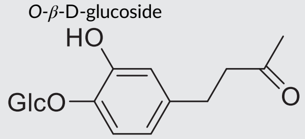
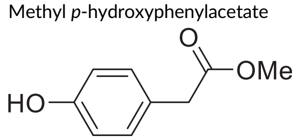
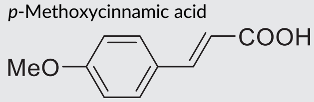
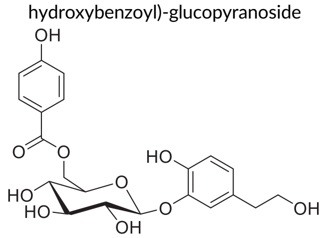
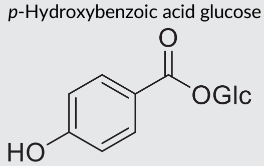
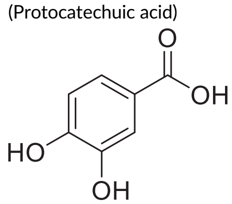
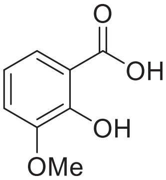
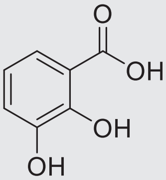
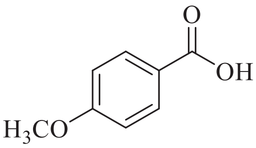
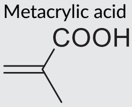
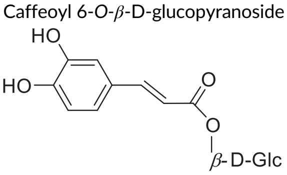
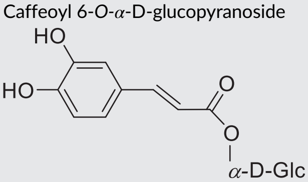
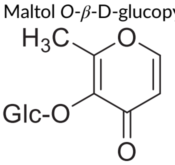
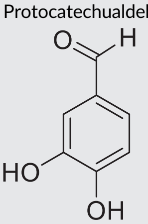
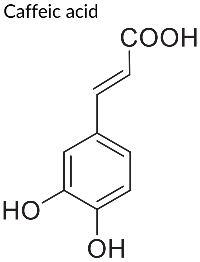
Compound No.	Compound name	Plant source	Plant parts/extraction solvent/fraction	Biological activity	References
510	4-(3,4-Dihydroxyphenyl)-2-butanone 	*V. negundo*	Leaves/70% EtOH, EtOAc fraction	Inhibitory effects on LPS-induced nitric oxide (NO) production in RAW264.7 macrophages and did not show any activity (IC_{50} value >100 μM	(Qiu et al., 2016)
		V. negundo	Fruit/MeOH, EtOAc fraction		(Fang, et al., 2016b)
511	3-(4-hydroxyphenyl)-1-(2,4,6-trimethoxyphenyl)-2-propen-1-one 	*V. leptobotrys*	Leaves and twigs/DCM extract	Inhibited HIV-1 replication by 77% at 15.9 μM.	(Pan et al., 2014)
512	Methyl caffeate 	*V. negundo*	Leaves/70% EtOH extract	Inhibitory effects on LPS-induced nitric oxide (NO) production in RAW264.7 macrophages with IC_{50} value 64.89 ± 4.77 μM. μM.	(Qiu et al., 2016)
513	4-(3′,4′-dihydroxyphenyl)-butan-2-one-4′-*O*-*β*-D-glucoside 	*V. cannabifolia*	Fruit/MeOH extract	DPPH radical scavenging activity.	(Yamasaki et al., 2008)
		V. rotundifolia	Leaves/MeOH extract		(Kouno et al., 1988)
514	Methyl *p*-hydroxyphenylacetate 	*V. negundo*	Leaves/70% EtOH extract	Inhibitory effects on nitric oxide (NO) production in RAW 264.7 macrophages with IC_{50} value 74.10±5.26 μM.	(Qiu et al., 2016)
515	*p*-Methoxycinnamic acid 	*V. negundo*	Leaves/70% EtOH extract	Inhibitory effects on nitric oxide (NO) production in RAW 264.7 macrophages with IC_{50} value 70.14±4.63 μM.	(Qiu et al., 2016)
516	4-Hydroxyphenethanol 3-*O*-*β*-D-(6′-*O*-*p*-hydroxybenzoyl)-glucopyranoside 	*V. negundo*	Leaves/70% EtOH extract	Inhibitory effects on LPS-induced nitric oxide (NO) production in RAW264.7 macrophages with IC_{50} value 30.76±2.21 μM.	(Qiu et al., 2016)
517	*p*-Hydroxybenzoic acid glucose ester 	*V. agnus-castus*	Fruit/*n*-hexane and MeOH extract		(S. Li et al., 2013)
518	3,4-Dihydroxy benzoic acid (Protocatechuic acid) 	*V. pinnata*	Leave/MeOH extract, EtOAc fraction		(Rudrapaul et al., 2014)
		V. negundo	Leaves/70% MeOH–H_2O (v/v) extract		(Mingqing Huang et al., 2015)
		V. rotundifolia	Fruit/EtOH extract, EtOAc fraction		(Wu et al., 2010)
		V. gardneriana	Stem barks/EtOH extract		(do Vale et al., 2017)

TABLE 9 (Continued)

Compound No.	Compound name	Plant source	Plant parts/extraction solvent/fraction	Biological activity	References
519	2-Hydroxy-3-methoxy benzoic acid 	*V. trifolia*	Leave/MeOH extract, *n*-BuOH fraction		(Tiwari, Thakur, et al., 2013)
520	2,3-Dihydroxy benzoic acid 	*V. trifolia*	Leave/MeOH extract, *n*-BuOH fraction		(Tiwari, Thakur, et al., 2013)
521	*p*-Methoxy benzoic acid 	*V. trifolia*	Leave/EtOH extract, EtOAc fraction		(Mohamed et al., 2012)
522	Metacrylic acid 	*V. polygama*	Leaves/hydroalcoholic extract, *n*-BuOH fraction		(Gallo et al., 2008)
523	Caffeoyl 6-*O*-*β*-D-glucopyranoside 	*V. polygama*	Leaves/hydroalcoholic extract, *n*-BuOH fraction		(Gallo et al., 2008)
524	Caffeoyl 6-*O*-*α*-D-glucopyranoside 	*V. polygama*	Leaves/hydroalcoholic extract, *n*-BuOH fraction		(Gallo et al., 2008)
525	Maltol *O*-*β*-D-glucopyranoside 	*V. limonifolia*	Leaves/MeOH extract, H_2O fraction		Thoa et al. (2018)
526	Protocatechualdehyde 	*V. negundo*	Leaves/70% MeOH–H_2O (v/v) extract		(Mingqing Huang et al., 2015)
527	Caffeic acid 	*V. negundo*	Leaves/70% MeOH–H_2O (v/v) extract		(Mingqing Huang et al., 2015)
		V. trifolia	Leaves/EtOH, EtOAc fraction	Strong antioxidant capacity with SC_{50} value 3.72 ± 0.12 μg/ml.	(Mohamed et al., 2012)

(Continues)

TABLE 9 (Continued)

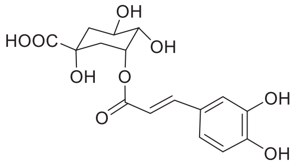
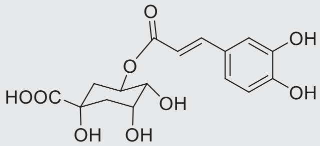
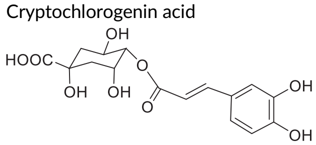
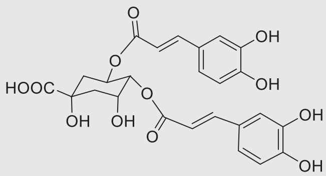
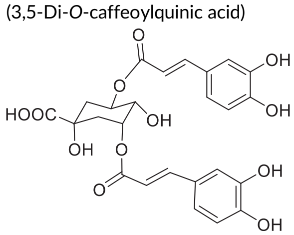
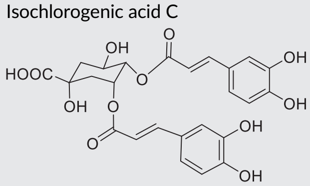
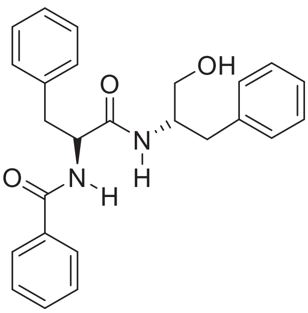
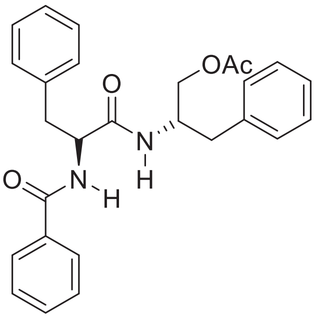
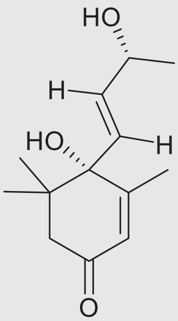
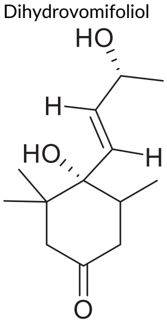
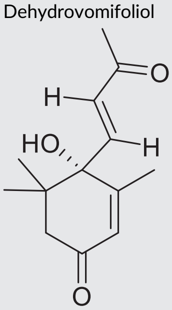
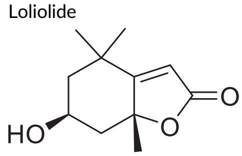
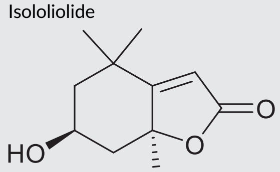
Compound No.	Compound name	Plant source	Plant parts/extraction solvent/fraction	Biological activity	References
528	Neochlorogenic acid 	*V. negundo*	Leaves/70% MeOH–H_2O (v/v) extract		(Mingqing Huang et al., 2015)
529	Chlorogenic acid 	*V. negundo*	Leaves/70% MeOH–H_2O (v/v) extract		(Mingqing Huang et al., 2015)
530	Cryptochlorogenin acid 	*V. negundo*	Leaves/70% MeOH–H_2O (v/v) extract		(Mingqing Huang et al., 2015)
531	Isochlorogenic acid B 	*V. negundo*	Leaves/70% MeOH–H_2O (v/v) extract		(Mingqing Huang et al., 2015)
532	Isochlorogenic acid A (3,5-Di-*O*-caffeoylquinic acid) 	*V. negundo*	Leaves/70% MeOH–H_2O (v/v) extract		(Mingqing Huang et al., 2015)
		V. cymosa	Fruits/EtOH extract, EtOAc fraction		(Leitao et al., 2008)
533	Isochlorogenic acid C 	*V. negundo*	Leaves/70% MeOH–H_2O (v/v) extract		(Mingqing Huang et al., 2015)
534	Aurantiamide 	*V. leptobotrys*	Leaves and twigs/DCM extract		(Pan et al., 2014)

TABLE 9 (Continued)

Compound No.	Compound name	Plant source	Plant parts/extraction solvent/fraction	Biological activity	References
535	Aurantiamide acetate 	*V. leptobotrys*	Leaves and twigs/DCM extract		(Pan et al., 2014)
536	Vomifoliol 	*V. leptobotrys*	Leaves and twigs/DCM extract		(Pan et al., 2014)
537	Dihydrovomifoliol 	*V. leptobotrys*	Leaves and twigs/DCM extract		(Pan et al., 2014)
538	Dehydrovomifoliol 	*V. leptobotrys*	Leaves and twigs/DCM extract		(Pan et al., 2014)
539	Loliolide 	*V. leptobotrys*	Leaves and twigs/DCM extract		(Pan et al., 2014)
		V. quinata	Leaves/MeOH, $CHCl_3$ fraction		(Deng et al., 2011)
540	Isololiolide 	*V. leptobotrys*	Leaves and twigs/DCM extract		(Pan et al., 2014)

(Continues)

TABLE 9 (Continued)

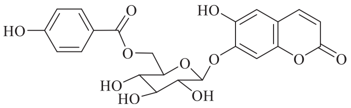
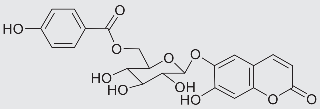
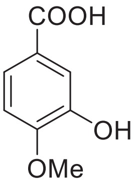
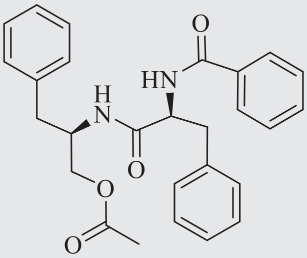
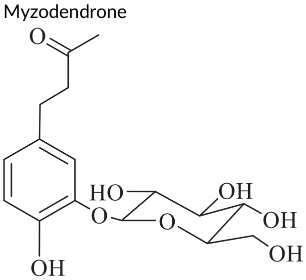
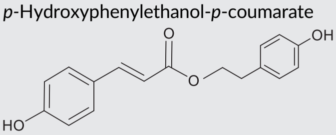
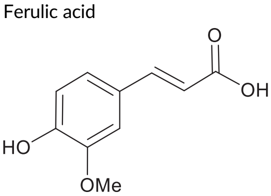
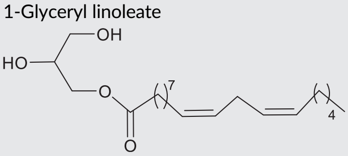
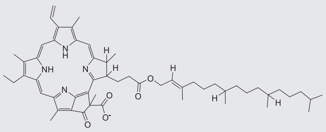
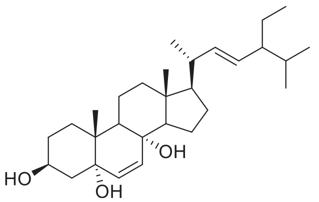
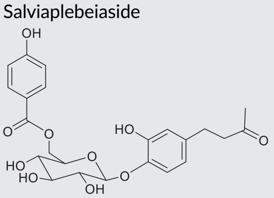
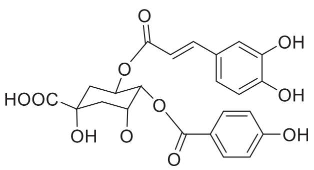
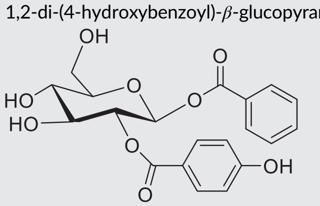
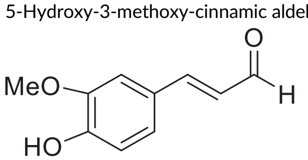
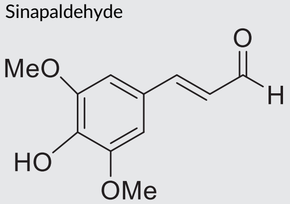
Compound No.	Compound name	Plant source	Plant parts/extraction solvent/fraction	Biological activity	References
541	Vitexnegheteroin I 	*V. negundo*	Leaves/ 95% EtOH extract, EtOAc fraction	Moderate radical scavenging activity {DPPH assay (IC_{50}, >100 μM), ABTS assay (IC_{50}, 2.05 ± 0.07 μM) and α–glucosidase inhibitory effects (IC_{50}, 4.75 ± 0.08 μM).	(Hu et al., 2017)
542	Vitexnegheteroin J 	*V. negundo*	Leaves/ 95% EtOH extract, EtOAc fraction	Moderate α–glucosidase inhibitory effects (IC_{50}, (IC_{50}, 5.62 ± 0.06 μM) μM).	(Hu et al., 2017)
543	4-Hydroxy-3-methoxybenzoic 	*V. gardneriana*	Stem barks/EtOH extract		(Vale et al., 2017)
		V. negundo	Aerial parts/EtOH extract		(Y. J. Chen et al., 2012)
544	Saropepate 	*V. negundo*	Whole plant/MeOH extract, EtOAc fraction		(Arai et al., 2013)
545	Myzodendrone 	*V. agnus-castus*	Flowering stems/MeOH extract, *n*-BuOH fraction		(Kuruüzüm-Uz et al., 2003)
546	*p*-Hydroxyphenylethanol-*p*-coumarate 	*V. agnus-castus*	Fruit/petroleum ether, 90% MeOH		(S.-N. Chen et al., 2011)
547	Ferulic acid 	*V. agnus-castus*	Fruit/petroleum ether, 90% MeOH		(S.-N. Chen et al., 2011)
548	1-Glyceryl linoleate 	*V. agnus-castus*	Fruit/petroleum ether, 90% MeOH		(S.-N. Chen et al., 2011)

TABLE 9 (Continued)

Compound No.	Compound name	Plant source	Plant parts/extraction solvent/fraction	Biological activity	References
549	*n*-Hentriacontanol $CH_3-(CH_2)_{29}-CH_2OH$	*V. negundo*	Defatted leaves/MeOH extract		(Chandramu et al., 2003)
550	Pheophytin *a* 	*V. pinnata*	Leaves	DPPH free radical scavenging activity.	(Kamal et al., 2011)
551	Erost-6,22-diene-3*β*,5*α*,8*α*-triol 	*V. kwangsiensia*	Fruits/MeOH extract, $CHCl_3$ fraction		Shen et al. (2019)
552	Salviaplebeiaside 	*V. negundo*	Leaves/70% EtOH extract	Exhibited good inhibitory effects on LPS-induced nitric oxide (NO) production in RAW264.7 macrophages with IC_{50} value 49.89 ± 4.12 μM.	(Qiu et al., 2016)
553	Castusic acid 	*V. agnus-castus*	Flowers/MeOH extract, H_2O fraction		(Kırmızıbekmez & Demir, 2016)
554	1,2-di-(4-hydroxybenzoyl)-*β*-glucopyranose 	*V. agnus-castus*	Flowers/MeOH extract, H_2O fraction		(Kırmızıbekmez & Demir, 2016)
555	5-Hydroxy-3-methoxy-cinnamic aldehyde 	*V. kwangsiensia*	Fruits/MeOH extract, $CHCl_3$ fraction		(Shen et al., 2019)
556	Sinapaldehyde 	*V. kwangsiensia*	Fruits/MeOH extract, $CHCl_3$ fraction		(Shen et al., 2019)

fiber model in mice using the *K*B, LNCaP, and LuI cancer cells at doses of 10, 20, and 40 mg/kg. With LNCaP cells, the compound inhibited the growth by 0–7.2 % at the *ip* site and 0–2.4 % at the sc site. While with *K*B cells, it was ineffective at the *ip* site and inhibited the growth by 0–8.2 % at the *sc* site. The compound was also ineffective in *in-vivo* mouse P-388 leukemia model (135 mg/kg) (Díaz et al., 2003).

5.2.3 | Antinociceptive activity

Essential oil from *V. agnus-castus* leaves significantly decreased pain responses in both formalin and tail immersion tests. In addition, the study concluded that the opioidergic system and muscarinergic receptors of cholinergic system might be involved in the antinociceptive effect (Khalilzadeh et al., 2015).

In another *in-vivo* study, *V. megapotamica* crude extract tested at 10 mg/kg dose exhibited a significant antinociceptive action in the complete Freund's adjuvant (CFA)-induced chronic inflammation model on rats (Hamann et al., 2016).

5.2.4 | Moulting hormone activity

24-*epi*-Pinnatasterone (**482**) and scabrasterone (**481**) isolated from the stem bark of *V. scabra* exhibited weak *in-vivo* moulting activity with EC_{50} values of 5.2×10^{-4} and 1.0×10^{-3} M, respectively based on the activity of positively control 20-hydroxyecdysone (**472**) (1.6×10^{-5} M) in Musca assay. The low moulting activity of these ecdysteroids was possibly due to lacking of a 22R-hydroxyl group in their molecule (Suksamrarn, Kumpun, & Yingyongnarongkul, 2002b).

5.2.5 | Cardioprotective activity

Vitex negundo leaf ethanolic extract showed a cardioprotective action on isoproterenol-induced myocardial necrosis in Wistar rats. The results demonstrated that a pretreatment with *V. negundo* extract prevented the deleterious effects related to myocardial infarction. In addition, the extract normalized cardiac marker enzymes, antioxidant enzymes, and signaling molecules (Prasad, Mopuri, Islam, & Kodidhela, 2017).

5.2.6 | Memory improvement activity

In a study with ovariectomized Wistar rats, the animals were submitted to Step-through passive avoidance (STPA) test for the evaluation of learning and memory. The results showed that oral administration of *V. agnus-castus* ethanolic extract improved learning and memory performance significantly. These results may be related to an increase in estrogen receptor alpha (ERα) gene expression in hippocampii of rat brain (Allahtavakoli, Honari, Pourabolli, et al., 2015).

5.2.7 | Hepatoprotective activity

The hydroalcoholic extract and *n*-butanolic fraction from fruit of *V. agnus-castus* L. displayed a significant protection on liver of rats with nonalcoholic fat liver disease (NAFLD) at 8.33 and 0.83 mg/kg concentrations, respectively (Moreno, Campos-Shimada, Da Costa, et al., 2015). Moreover, the protective effect of *Vitex* honey obtained from *V. negundo* was confirmed on paracetamol-induced liver injury in rats model. Results demonstrated a significant reduction in AST and ALT activities and MDA levels, while also enhancement was observed of the SOD and glutathione peroxidase activities at dose 20 g kg^{-1} (Y. Wang et al., 2015). *V. doniana* methanolic extract from fresh fruit pulp demonstrated a hepatoprotective effect in mice induced by acetaminophen. The extract exhibited an increase of SOD, CAT, glutathione peroxidase, and glutathione reductase and a normalization of AST and ALT serum levels at 100 mg/kg dose (Ajiboye, 2015).

5.2.8 | Gastroprotective activity

Vitex pubescens Vahl ethanolic leaf extract at 500 mg/kg reduced significantly the ulcer area (79%) on ethanol-induced gastric hemorrhagic ulceration model using Sprague–Dawley rats. According to the authors, this gastroprotective activity might be related to increased antioxidant enzymes activities (CAT, SOD, and GSH), decreased lipid peroxidation upsurge of HSP70, and reduced expression of Bax proteins (Al-Wajeeh et al., 2016).

5.2.9 | Antiaging activity

The ethanolic extract from *V. agnus-castus* (600 mg/kg per day) was able to improve antioxidant defenses like superoxide dismutase (SOD) and catalase (CAT) to reduce malondialdehyde (MDA) levels and attenuate the aging effects caused by D-galactose in mice. The treatment with *Vitex* extract minimizes atrophy of the endometrium, degeneration of follicles, alterations in serum levels of LH and FSH, and reduces the decline in estrogen through antioxidant responses (Ahangarpour, Najimi, & Farbood, 2016). Other study investigating the aging effects included by D-galactose demonstrated that hydroalcoholic fruit extract from *V. agnus-castus* diminished body weight gain and the loss of kidney weight in female mice. Moreover, kidney histological analyses revealed that the extract tested was able to reduce vasodilation, brush border loss, tubular dilation, and cell swelling in proximal tubules (Oroojan, Ahangarpour, Khorsandi, & Najimi, 2016).

5.2.10 | Endocrine effects

Essential oil from *V. agnus-castus* possessed an endocrine effect on pituitary-thyroid and adrenocortical axes in middle-aged male rats. The essential oil of *Vitex* modulated the levels of triiodothyronine (TH) and adrenocorticotrophic hormone (ACTH) hormones, often involved in anxiety and depressive disorders (Šošić-Jurjević, Ajdžanović, Filipović, et al., 2016).

5.2.11 | Ischemic tissue injury protective activity

Aqueous extract of *V. doniana* leaves showed a significant protective effect on ischemic tissue injury in rats submitted to testicular torsion. Histology analyses of group treated with 200 mg of *V. doniana* Sweet demonstrate significant protection of seminiferous tubule diameter with reduction of the luminal size of germinal epithelium (Adelodun, Adewole, Bejide, et al., 2016).

6 | CONCLUSIONS AND FUTURE DIRECTIONS

The different species of *Vitex* are being used in traditional medicines in different parts of the world. The plants are scattered in many countries such as India, Iran, Malaysia, Sri Lanka, China, Pakistan, Bangladesh, Philippines, Maldives, Guimaras Island, Japan, Madagascar, Thailand, Futuna, South Pacific Island, Hawaii, Mexico, and New Zealand. The current review documented the up-to-date ethnobotanical, phytochemical, and pharmacological research data of the genus *Vitex*. The phytochemical studies on the various species of *Vitex* reported isolation and characterization of a total of 556 chemical compounds, and their structure was mentioned in the review. The volume of experimental records gives evidence of the presence of a rich variety of phytochemicals *viz*. iridoids, diterpenoids, triterpenoids, flavonoids, lignans, sesquiterpenoids, monoterpenoid, ecdysteroids, etc., with a wide range of bioactivities. Out of the reported 556 chemical compounds, 38 are iridoids, 144 are diterpenoids, 71 are triterpenoids, 99 are flavonoids, 75 are lignans, 26 are sesquiterpenoids, 16 are monoterpenoids, 27 are ecdysteroids, and 61 are other compounds. Many of the isolated compounds, crude extract and fractions were evaluated for their pharmacological activity. In addition, diterpenoids, flavonoids, lignans, triterpenoids, and Iridoids were found to be the major chemical constituents of the genus *Vitex*, and these constituents are known for their biological efficiency. Thus, these constituents should be explored for their different pharmacological activities. It is interesting to note that although there are many studies on the plants of the genus, most of them are limited to a few *Vitex* species viz. *V. negundo* L., *V. agnus-castus* L., *V. rotundifolia* L.f., *V. trifolia* L., *V. cannabifolia* Siebold & Zucc., etc. We speculate that this might be due to the extensive use of the species in traditional medicine systems and herbal supplements worldwide. It will be important that future research systematically study all yet unexplored as well as less explored multiple species of the genus for novel phytochemicals with varied useful bioactivities so that cost-effective, prospective medicinal drug, and healthcare products can be developed at a large scale in the future. Moreover, very limited data are available for the toxicity profile of the genus *Vitex*. This specifies that detailed toxicity study is necessary to be carried out for different pharmacologically active fractions as well as pure phytochemicals of medicinally important species of the genus *Vitex*. This may open ways for discovery of new drugs for treating various health disorders and benefit of mankind.

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CONFLICT OF INTEREST

The authors declared no conflict of interest.

AUTHOR CONTRIBUTIONS

Niranjan Das conceived the study and wrote the first draft of the manuscript. Andréia C. F. Salgueiro, Debasish Roy Choudhury, Sudip Kumar Mandal, Rajan Logesh, Md Mahadi Hassan, and Hari Prasad Devkota supported the writing of the first draft of the manuscript and revised the manuscript. All of the authors made conceptual contributions to the content, have corrected and improved the first draft, and approved the final manuscript.

DATA AVAILABILITY STATEMENT

No data were generated in this work.

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