REVIEW ARTICLE

RECORDS OF PHARMACEUTICAL AND BIOMEDICAL SCIENCES

Chemical Review on *Artemisia herba alba*

Sarah S. Hasan, Enas E. Eltamany, Reda F. A. Abdelhameed, Eman S. Habib and Safwat A. Ahmed*

Department of Pharmacognosy, Faculty of Pharmacy, Suez Canal University, Ismailia 41522, Egypt

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***Correspondence Author:**

Tel: 01092638387
E-mail:
Safwat-aa@yahoo.com

Abstract

Natural products represent a very important entity and valuable leads in pharmaceutical drug discovery and drug design as the lead compound can be originally obtained from a natural source, can be a precursor for a semi synthetic compound, can be totally synthesized to mimic a natural product or can act as a template for a structurally different total synthetic compound. Plants were used as the source of many drugs as digoxin, taxol, morphine and salicylic acid. *Artemisia herba alba* Asso. as one of the most important medicinal plants is a plant belongs to family Asteraceae. It is well known in Arabic as shih. It has been used in traditional medicine for treatment of diabetes, hypertension and for its antibacterial and analgesic properties. This review summarizes the diverse chemical constituents of *Artemisia herba alba* which includes many chemical classes as sesquiterpenes, monoterpenes, flavonoids, flavonoid glycosides, sterols, coumarins, essential oils and many miscellaneous compounds.

Keywords: *Artemisia herba alba*, sesquiterpenes, flavonoids.

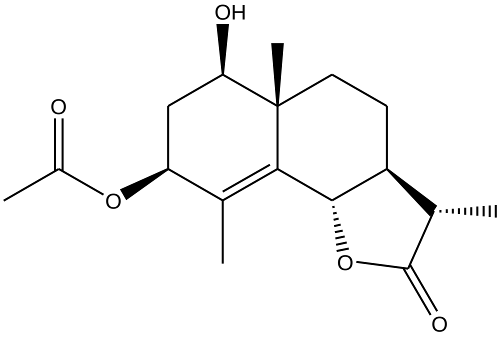
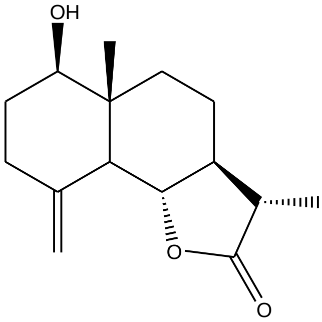
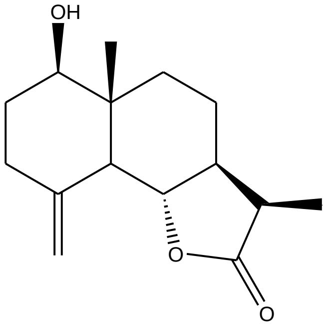
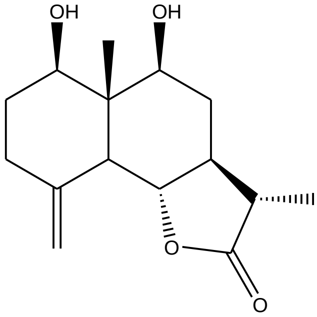
1. Introduction

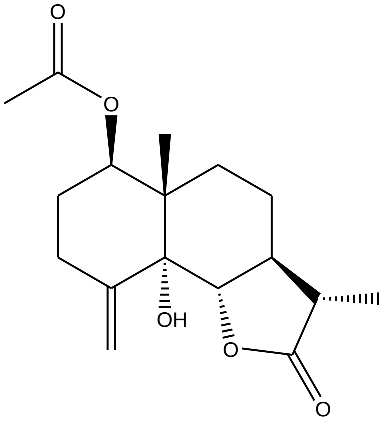
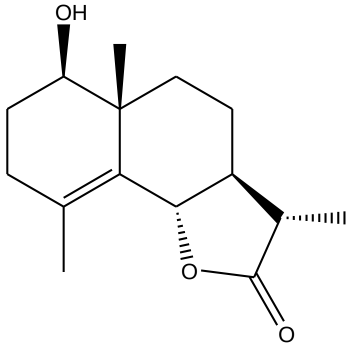
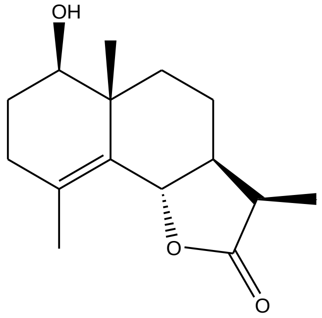
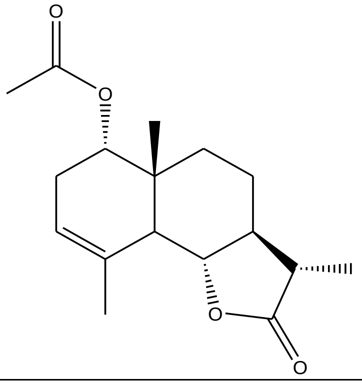
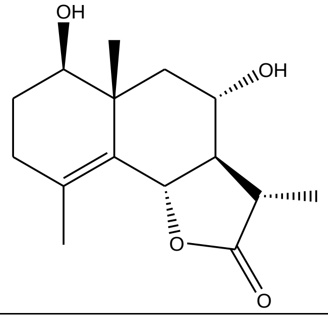
Natural products were and still one of the most important tools to treat diseases and decrease mortality rates. Plants as the most important entity of natural products were the source of many drugs as digoxin, vincristine, taxol, atropine, colchicine, ephedrine, morphine and salicylic acid (Orhan, 2014). In many cases, plant-based medicines are used in the form of extracts in an unpurified state so the role of pharmacognosy is to identify and purify the active compounds responsible for the pharmacological action. Natural products present a great scope to discover new lead compounds that can be converted into drugs with chemical structure diversity (Dzobo, 2022).

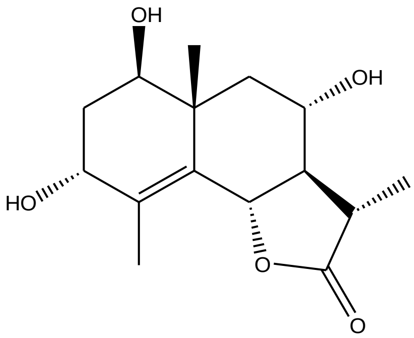
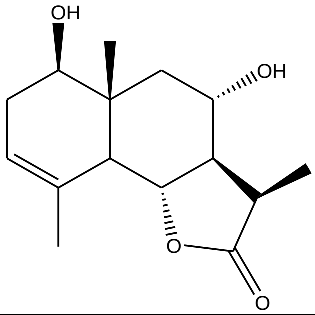
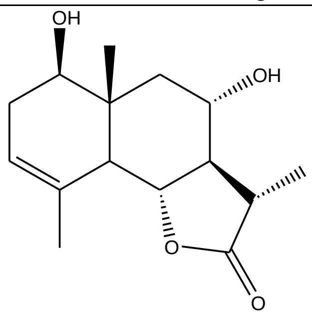
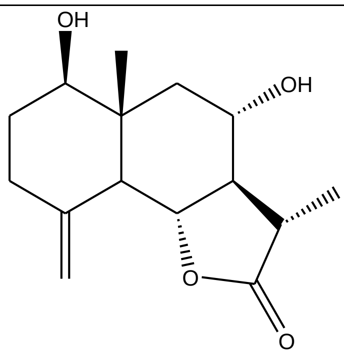
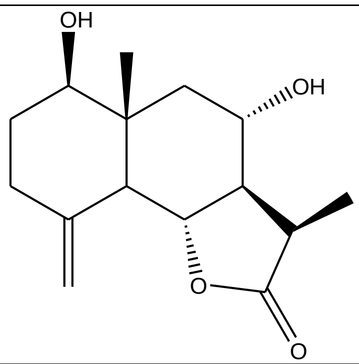
Artemisia herba alba Asso. is a plant, belongs to family Asteraceae, which is considered one of the largest plant families as it contains about 1000 genera and over 20000 species (Nigam *et al*., 2019). *Artemisia herba alba* has many synonyms as desert wormwood, shih in Arabic culture and armoise blanche in French. It has been used in traditional medicine of many countries for treatment of diabetes, hypertension and for its anthelmintic, antibacterial, analgesic and antispasmodic properties (Mohamed *et al*., 2010). Certainly, these various activities and uses are attributed to the presence of various chemical constituents in the plant.

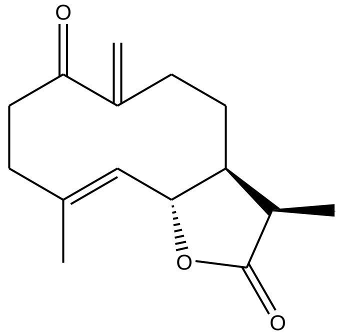
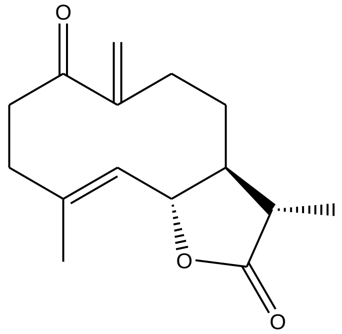
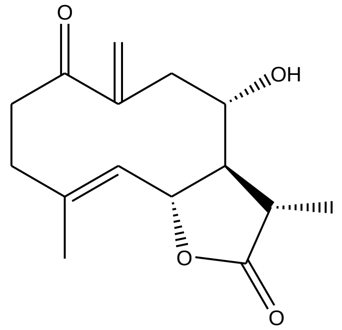
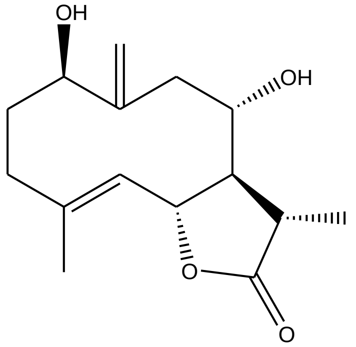
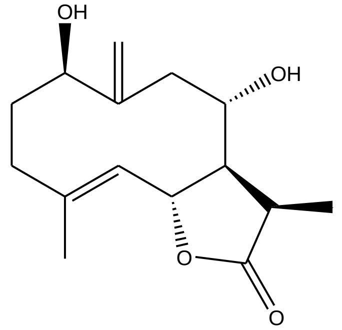
2. Chemical constituents reported in *Artemisia herba alba*

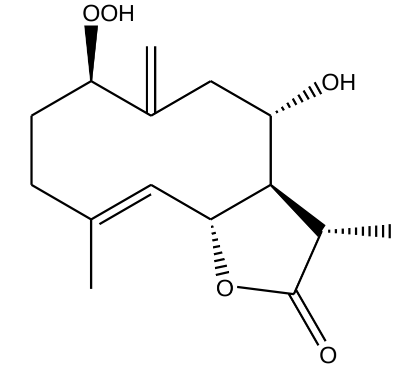
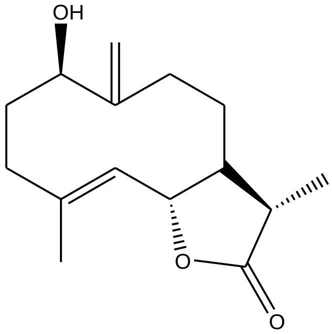
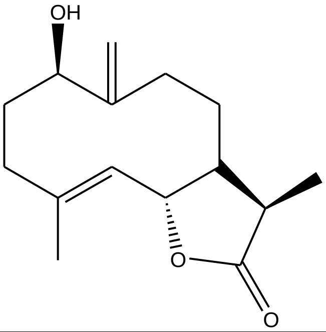
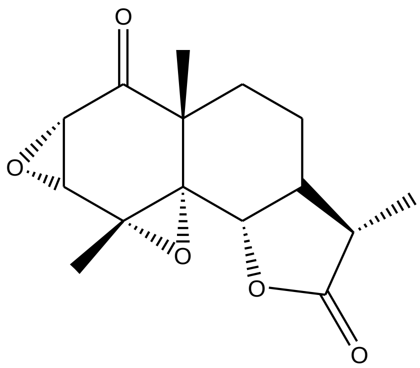
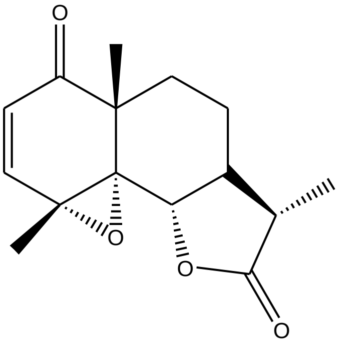
Table 1. Sesquiterpenes and sesquiterpene lactones

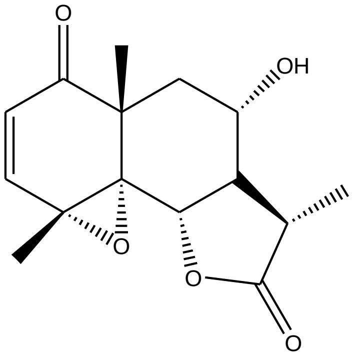
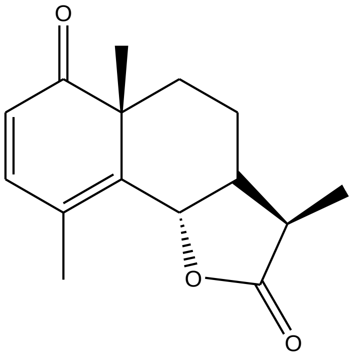
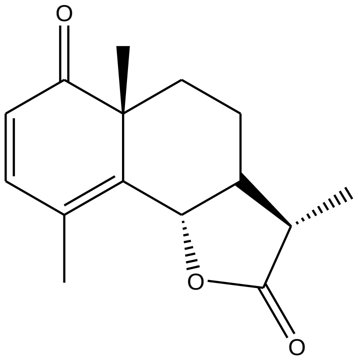
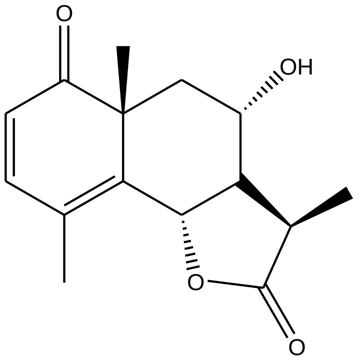
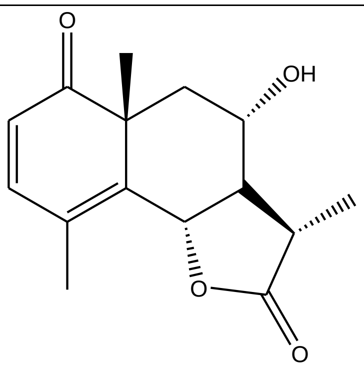
Compound name	Compound structure	Reference
Torrentin		(Sanz *et al*., 1990b) (Sanz and Marco, 1991)
Dihydroreynosin		(Gomis *et al*., 1979) (Marco, 1989) (Sanz *et al*., 1990b)
11α,13-Dihydroreynosin		(Marco, 1989) (Sanz and Marco, 1991) (Sanz *et al*., 1990a) (Sanz *et al*., 1990b)
9β-Hydroxy-11,13-dihydroreynosin		(Ahmed *et al*., 1990) (Marco *et al*., 1994)

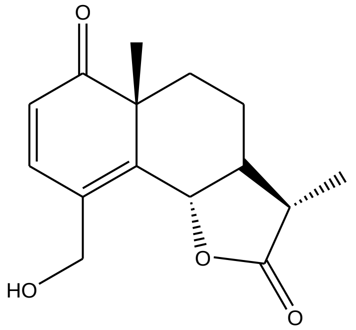
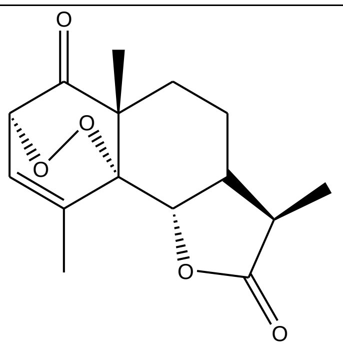
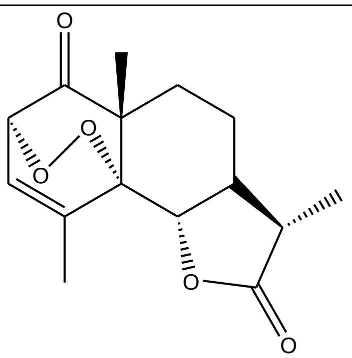
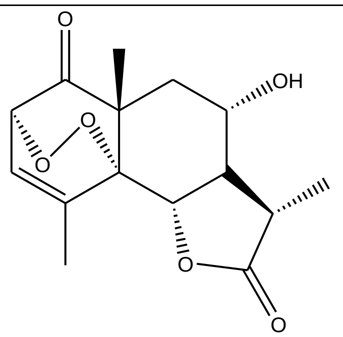
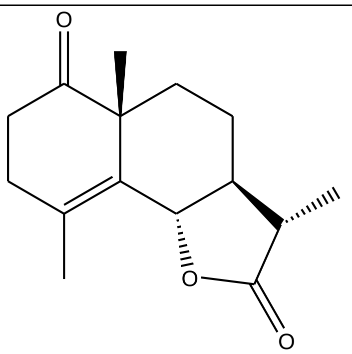
5α-Hydroxy-11,13-dihydroreynosin acetate		(Ahmed *et al*., 1990)
Artesin		(Marco, 1989) (Sanz *et al*., 1990a) (Sanz *et al*., 1990b)
11-Epiartesin		(Marco, 1989) (Sanz *et al*., 1990a) (Sanz *et al*., 1990b)
11β,13-Dihydrodouglanin acetate		(Marco, 1989)
1β,8α-Dihydroxyeudesm-4-en-6β,7α,11βH-12,6-olide		(Marco, 1989)

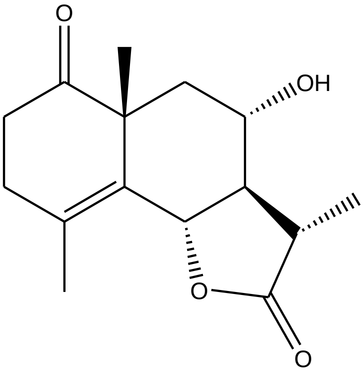
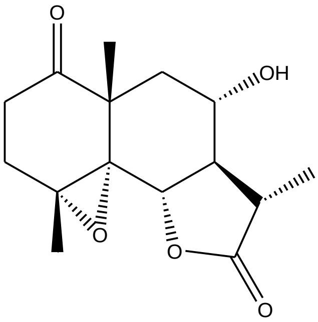
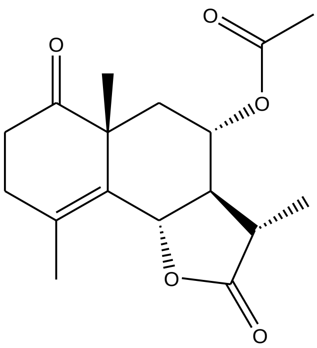
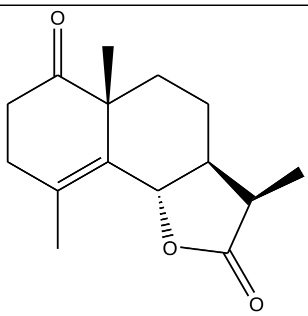
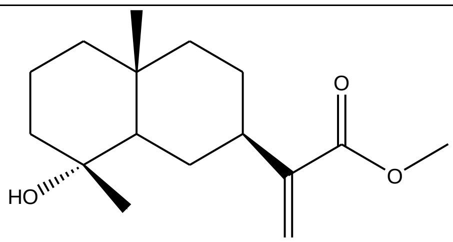
1,3,8-trihydroxyeudesm-4-en-7α,11βH-12,6α-olide		(Mohamed T. A. *et al*., 2019)
1β,8α-dihydroxy-11α,13-dihydrobalchanin		(Mohamed T. A. *et al*., 2019)
1β,8α-Dihydroxyeudesm-3-en-6β,7α,11βH-12,6-olide		(Marco, 1989)
Artapshin		(Marco, 1989) (Sanz *et al*., 1990b)
11-Epiartapshin		(Mohamed T. A. *et al*., 2019)

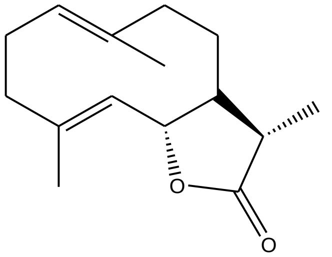
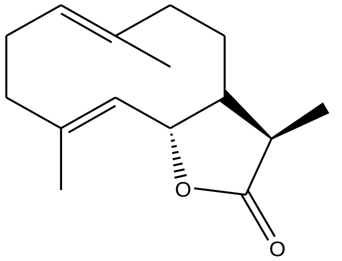
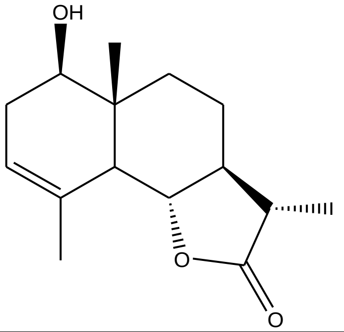
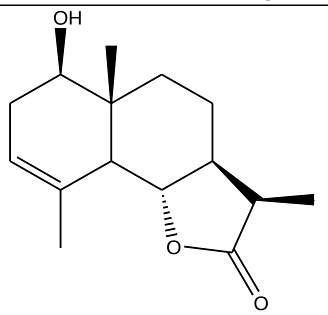
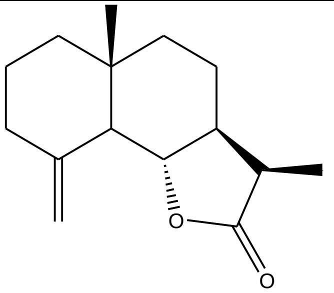
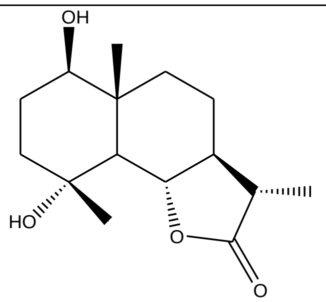
1-Oxogermacr-4,10(14)-dien-6β,7α,11α H-12,6-olide		(Marco, 1989)
1-Oxogermacr-4,10(14)-dien-6β,7α,11β H-12,6-olide		(Marco, 1989)
1-Oxo-8α-Hydroxy-germacr-4,10(14)-dien-6β,7α,11β H-12,6-olide		(Marco, 1989)
Shonachalin A		(Marco, 1989)
11-Epishonachalin A		(Marco, 1989)

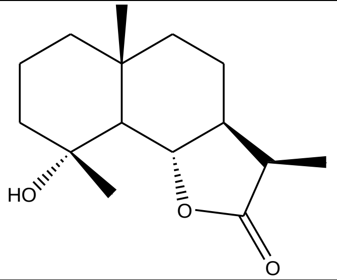
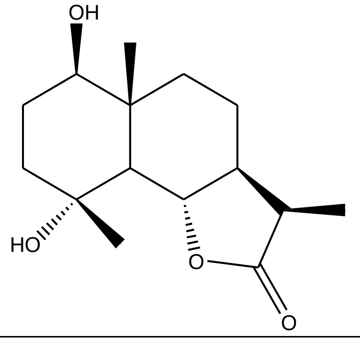
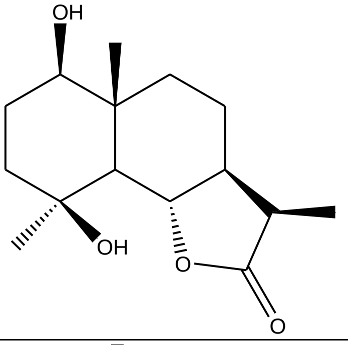
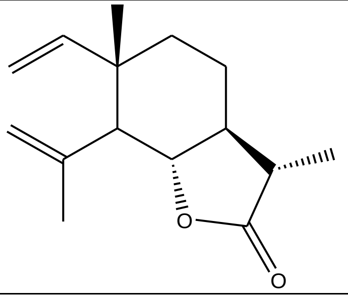
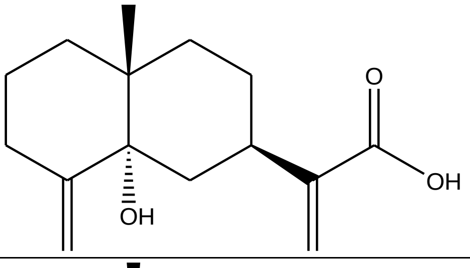
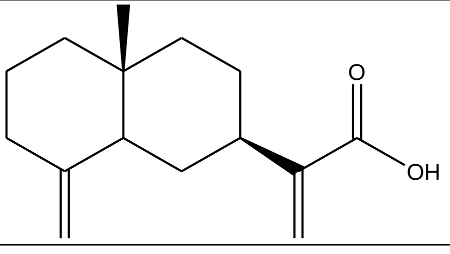
1β-Hydroperoxy-8α-hydroxy germacr-4,10(14)-dien-6β,7α,11β H-12,6-olide		(Marco, 1989)
lβ-Hydroxy-6βH,7αH, 11βH-germacr-4,10 (14)-dien-12,6-olide (Gallicin)		(Marco, 1989) (Sanz *et al*., 1990b)
lβ-Hydroxy-6βH,7αH, 11αH-germacr-4,10 (14)-dien-12,6-olide (11-Epigallicin)		(Marco, 1989) (Sanz *et al*., 1990a) (Gordon *et al*., 1981)
1-Oxo-2α,3α,4α,5α-diepoxyeudesman-11βH-12,6α-olide		(Marco *et al*., 1990)
1-Oxo-4α,5α-Epoxyeudesm-2-en-11βH-12,6α-olide		(Marco *et al*., 1990)

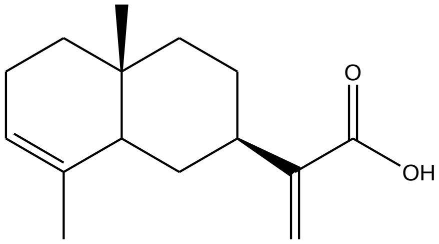
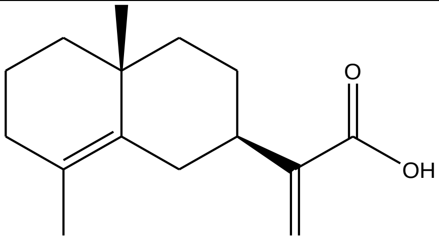
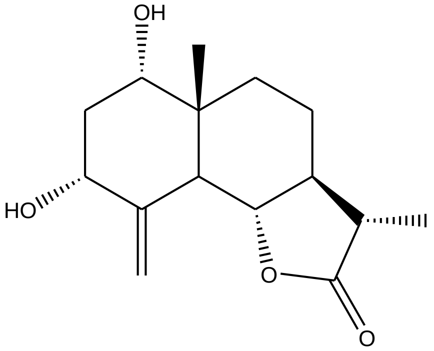
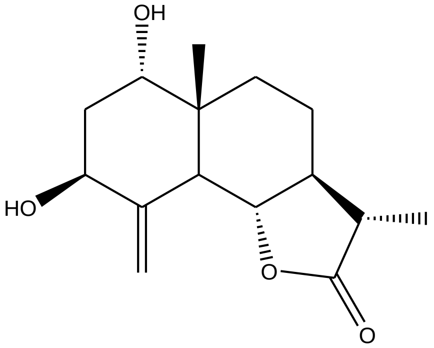
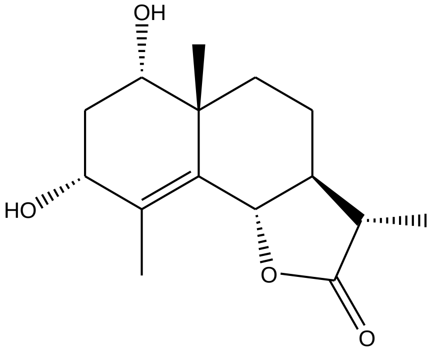
1-Oxo-8α-Hydroxy-4α,5α-epoxyeudesm-2-en-11β H-12,6α-olide		(Marco *et al*., 1990)
1-Oxoeudesma-2,4-dien-11αH-12,6α-olide		(Marco *et al*., 1990)
1-Oxoeudesma-2,4-dien-11βH-12,6α-olide		(Marco *et al*., 1990)
1-Oxo-8α-hydroxyeudesma-2,4-dien-11α H-12,6α-olide		(Marco *et al*., 1990)
1-Oxo-8α-hydroxyeudesma-2,4-dien-11β H-12,6α-olide		(Marco *et al*., 1990)

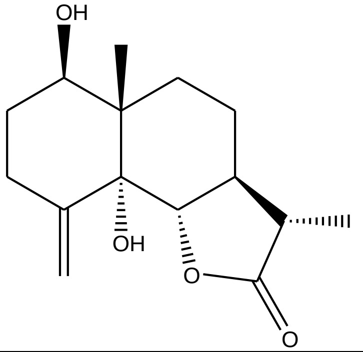
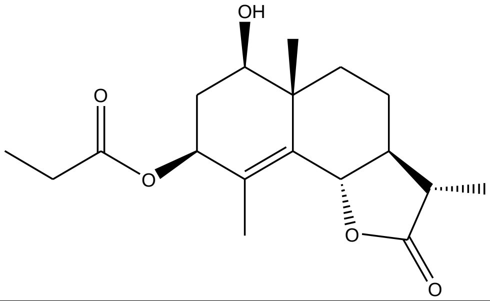
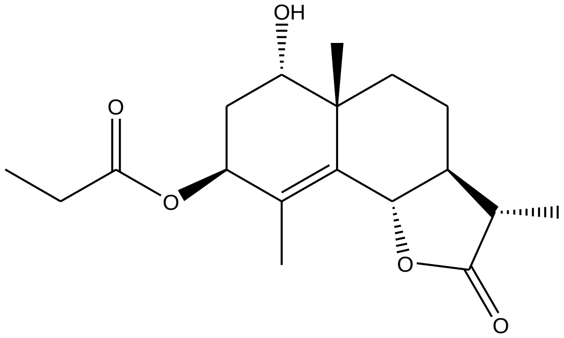
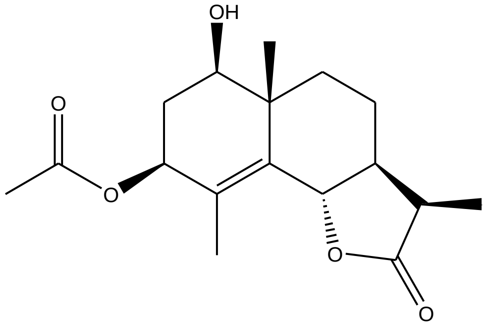
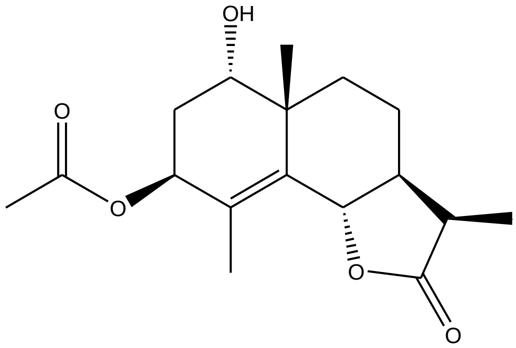
1-Oxo-15-hydroxyeudesma-2,4-dien-11βH-12,6α-olide		(Marco *et al*., 1990)
1-Oxo-2α,5α-peroxyeudesm-3-en-11αH-12,6α-olide		(Marco *et al*., 1990)
1-Oxo-2α,5α-peroxyeudesm-3-en-11βH-12,6α-olide		(Marco *et al*., 1990)
1-Oxo-8α-Hydroxy-2α,5α-peroxyeudesm-3-en-11βH-12,6α-olide		(Marco *et al*., 1990)
Taurin		(Marco, 1989) (Boriky *et al*., 1996) (Sanz *et al*., 1990b)

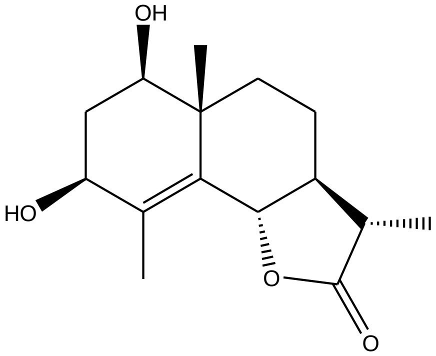
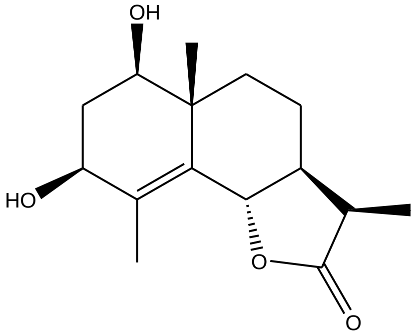
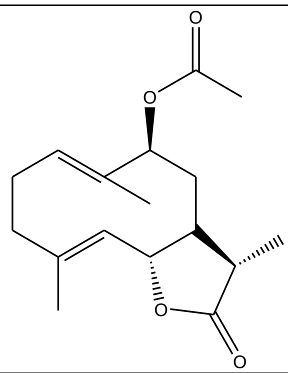
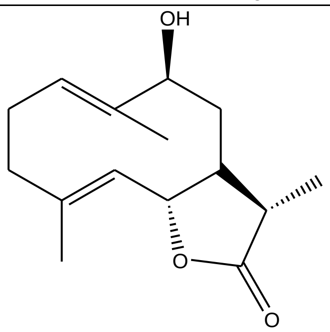
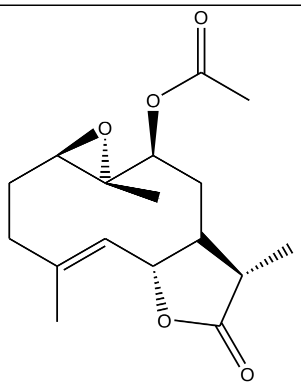
8α-Hydroxytaurin		(Sanz *et al*., 1990b)
8α-Hydroxy-4α,5α-epoxytaurin		(Boriky *et al*., 1996)
8α-Acetoxytaurin		(Marco *et al*., 1994)
11-Epitaurin		(Sanz *et al*., 1990a) (Sanz *et al*., 1990b)
Vachanic acid		(Sanz *et al*., 1990a) (Sanz *et al*., 1990b)

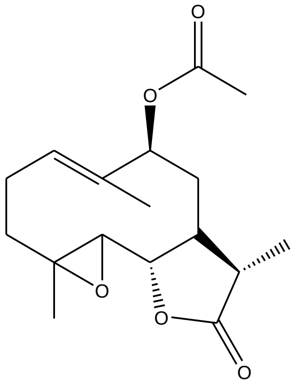
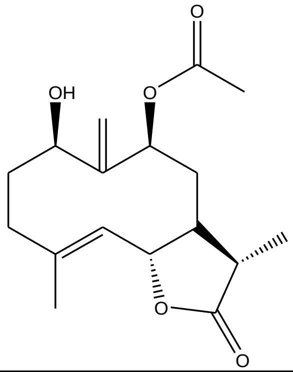
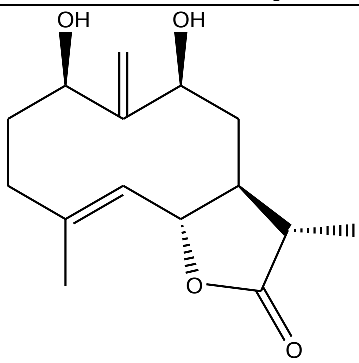
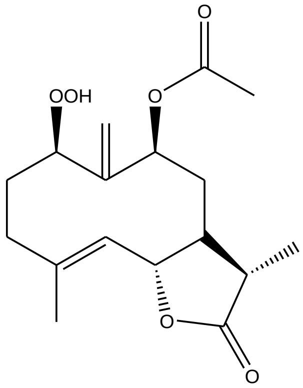
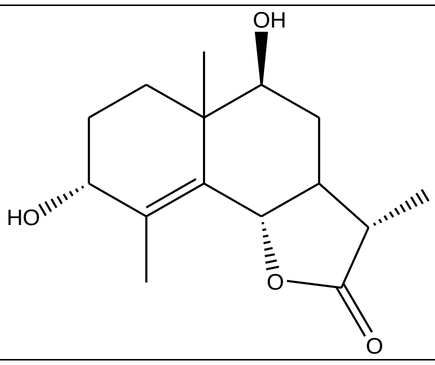
Dihydrocostunolide		(Sanz *et al*., 1990b)
11α, 13-Dihydrocostunolide		(Sanz *et al*., 1990a) (Sanz *et al*., 1990b)
Dihydrosantamarin		(Sanz *et al*., 1990b)
11α,13-Dihydrosantamarin		(Sanz *et al*., 1990a) (Sanz *et al*., 1990b)
11α,13-Dihydro-β-cyclocostunolide		(Sanz *et al*., 1990a)
1β-Hydroxy colartin		(Sanz *et al*., 1990b)

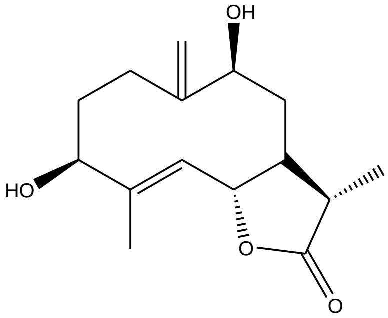
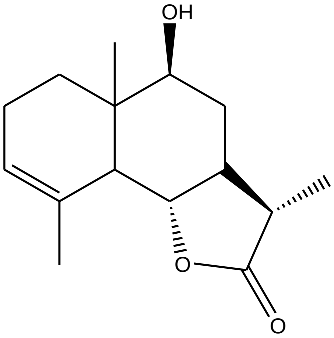
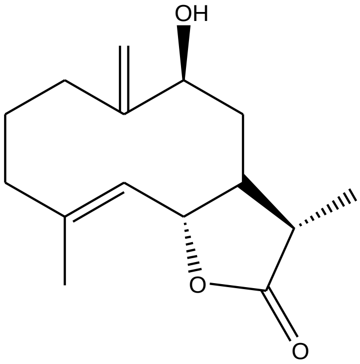
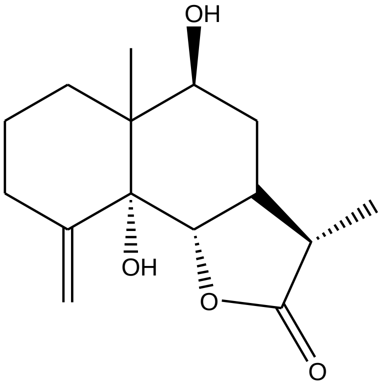
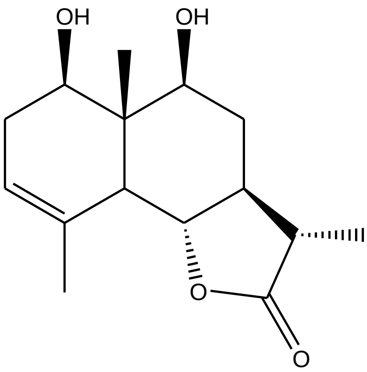
11-Epicolartin		(Sanz *et al*., 1990a)
1β-Hydroxy-11-epicolartin		(Sanz *et al*., 1990a)
1β-Hydroxy-4,11-diepicolartin		(Sanz *et al*., 1990a)
Saussurea lactone		(Sanz *et al*., 1990a)
5α-Hydroxy-7αH-eudesma-4(15),11(13)-dien-12-oic acid		(Sanz *et al*., 1990b)
7αH-eudesma-4(15),11(13)-dien-12-oic acid		(Sanz *et al*., 1990b)

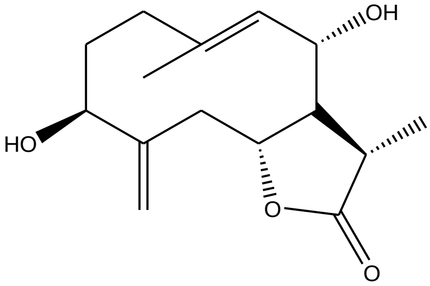
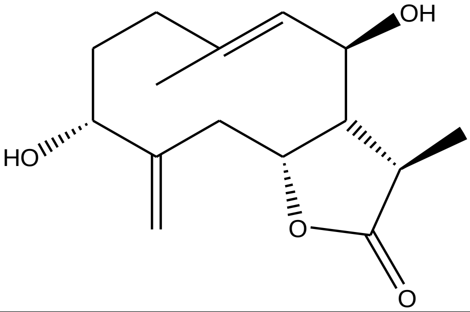
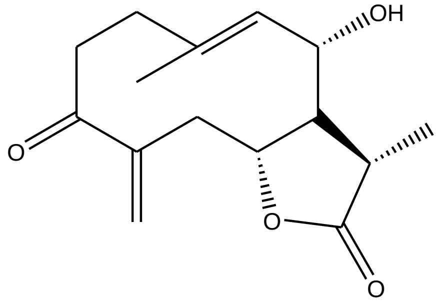
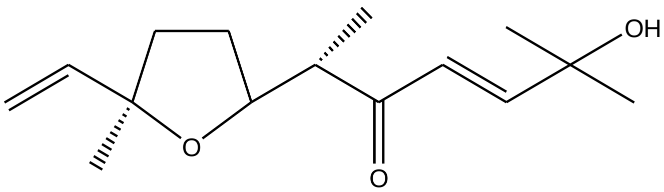
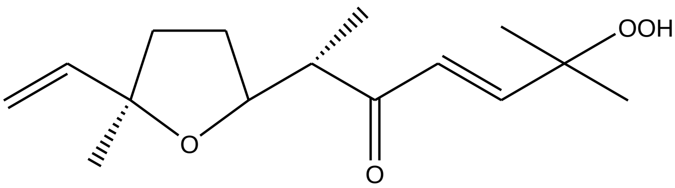
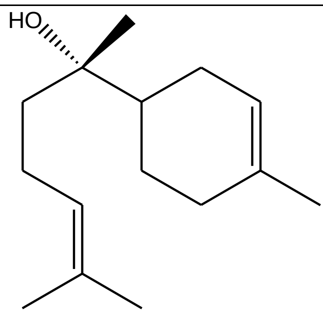
7αH-eudesma-3,11(13)-dien-12-oic acid		(Sanz *et al*., 1990b)
7αH-eudesma-4,11(13)-dien-12-oic acid		(Sanz *et al*., 1990b)
Erivanin		(Marco, 1989) (Boriky *et al*., 1996)
3-Epi-erivanin		(Sanz *et al*., 1990b)
Isoerivanin		(Boriky *et al*., 1996)

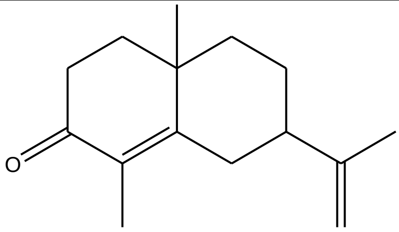
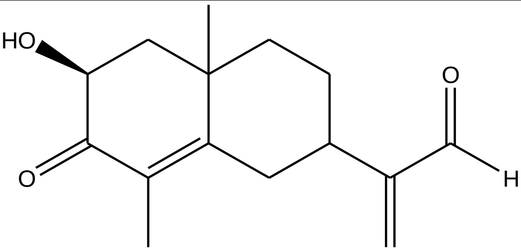
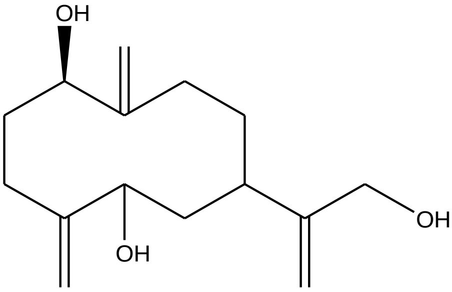
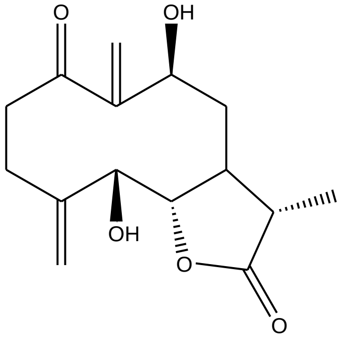
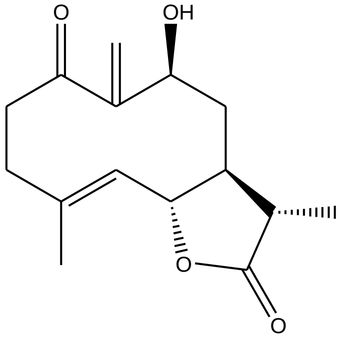
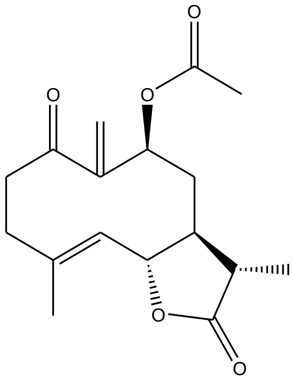
Artemin		(Marco, 1989)
1β-Hydroxy-3β-propionyloxy-6β,7α,11β H-eudesm-4-en-12,6-olide		(Sanz *et al*., 1990b)
1α-Hydroxy-3β-propionyloxy-6β,7α,11β H-eudesm-4-en-12,6-olide		(Sanz *et al*., 1990b)
11-Epitorrentin		(Sanz and Marco, 1991)
1,11-Diepitorrentin		(Sanz and Marco, 1991)

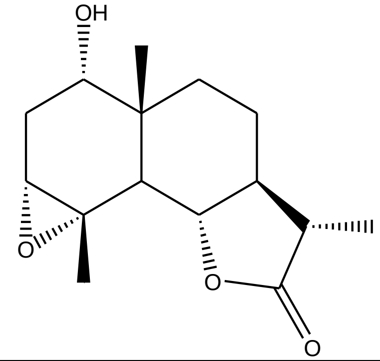
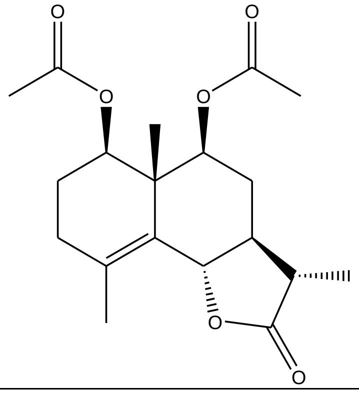
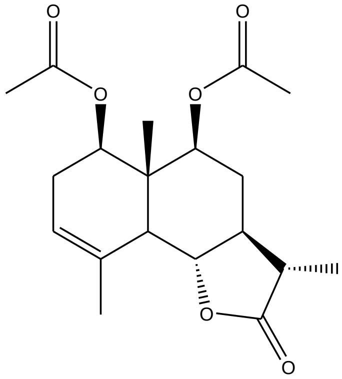
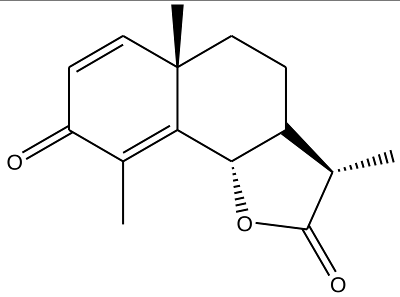
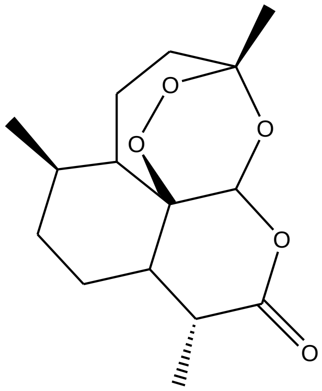
Deacetyltorrentin		(Sanz and Marco, 1991)
11-Epi-deacetyltorrentin		(Sanz and Marco, 1991)
Herbolide A		(Segal *et al.*, 1977) (Segal *et al.*, 1983) (Marco *et al.*, 1994)
Deacetyl herbolide A		(Segal *et al.*, 1983) (Marco *et al.*, 1994)
Herbolide B		(Segal *et al.*, 1977) (Segal *et al.*, 1983) (Marco *et al.*, 1994)

Herbolide C		(Segal *et al.*, 1977) (Segal *et al.*, 1983)
Herbolide D		(Segal *et al.*, 1983) (Marco *et al.*, 1994)
Deacetylherbolide D		(Marco *et al.*, 1994)
1β-Hydroperoxy-9β-acetoxygermacr-4,10(14)-dien-6β,11βH-12,6-olide		(Marco *et al.*, 1994)
Herbolide E		(Segal *et al.*, 1984) (Segal *et al.*, 1985)

Herbolide F		(Segal *et al.*, 1984) (Segal *et al.*, 1985)
Herbolide G		(Segal *et al.*, 1985)
Herbolide H		(Segal *et al.*, 1985)
Herbolide I		(Segal *et al.*, 1985)
1β,9β-Dihydroxyeudesm-3-en-5α,6β,11βH-12,6-olide		(Marco *et al.*, 1994)

3β, 8α-Dihydroxy-6βH,7αH,11βH germacr-4(15),9(10)-dien-12,6-olide (11βH tatridine D)		(Gordon *et al.*, 1981)
3α,8β-dihydroxy-7βH,11αH germacr-4(15),9(10)-dien-12,6α-olide		(Mohamed T. A. *et al.*, 2019)
8α-Hydroxy-3-oxo -6βH,7αH,11βH germacr-4(15),9(10)-dien-12,6-olide (3-oxo-11βH tatridine D)		(Gordon *et al.*, 1981)
2,6,10-trimethyl-cis-7,10-oxido-dodeca-3E, 11-dien-2-ol-5-one (Hydroxydavanone)		(Gordon *et al.*, 1981) (Marco *et al.*, 1994)
2,6,10-trimethyl-2-hydroperoxy-cis-7,10-oxido-dodeca-3E,11-dien-5-one		(Marco *et al.*, 1994)
α-Bisabolol		(Sanz *et al.*, 1990a)

α-Cyperone		(Sanz *et al*., 1990a)
2β-Hydroxy-13-oxo-α-cyperene		(Ahmed *et al*., 1990)
1β,5,12-Trihydroxygermacr-10(14), 4(15), 11(13)-triene		(Ahmed *et al*., 1990)
5β,9β-Dihydroxy-1-Oxo-germacr-10(14),4(15)-dien-12,6-olide		(Ahmed *et al*., 1990)
1-Oxo-9β-Hydroxygermacr-4,10(14)-dien-6β,11βH-12,6-olide		(Marco *et al*., 1994)
1-Oxo-9β-acetoxygermacr-4,10(14)-dien-6β,11βH-12,6-olide		(Marco *et al*., 1994)

Herbalbin		(Boriky *et al*., 1996)
1β,9β-Diacetoxyeudesm-4-en-6β,11βH-12,6-olide		(Laid *et al*., 2008)
1β,9β-Diacetoxyeudesm-3-en-6β,11βH-12,6-olide		(Laid *et al*., 2008)
α-Santonin		(Khafagy *et al*., 1971) (Gomis *et al*., 1979) (Boriky *et al*., 1996)
Artemisinin		(El Naggar, 2012)

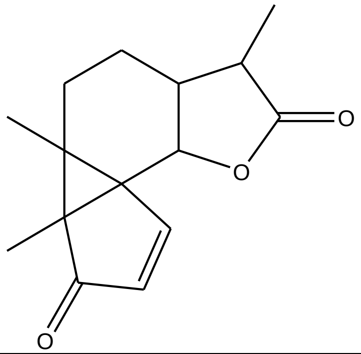
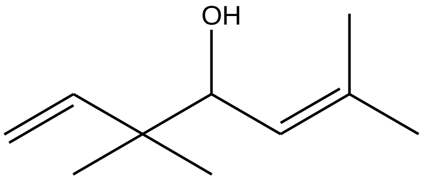
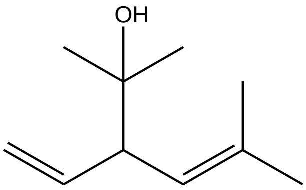
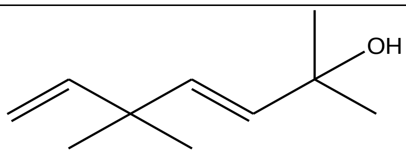
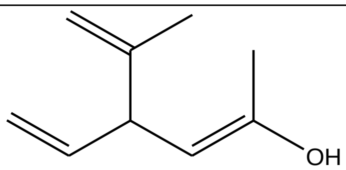
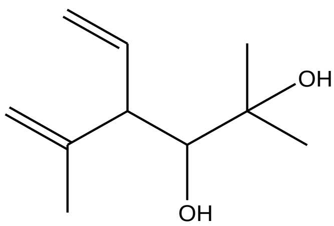
Lumisantonin		(Ahmed *et al*., 1990)

Table 2. Monoterpenes

Compound name	Compound structure	Reference
Artemisia alcohol		(Segal *et al*., 1980)
Santolina alcohol		(Segal *et al*., 1980)
Yomogi alcohol		(Segal *et al*., 1980)
Lyratol		(Segal *et al*., 1980)
4,5-Dihydroxysantolina-1,8-diene		(Marco, 1989)

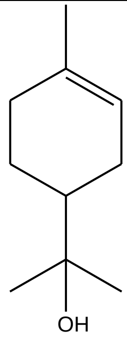
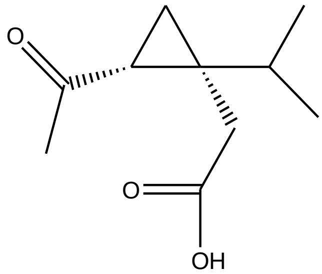
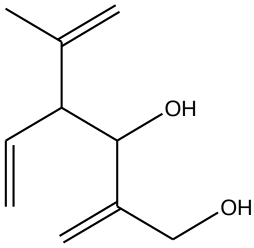
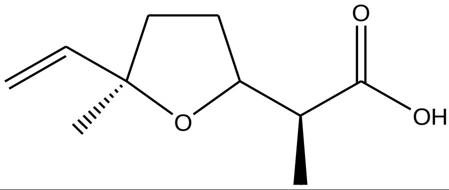
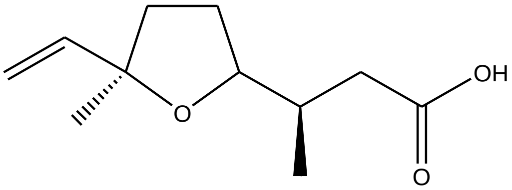
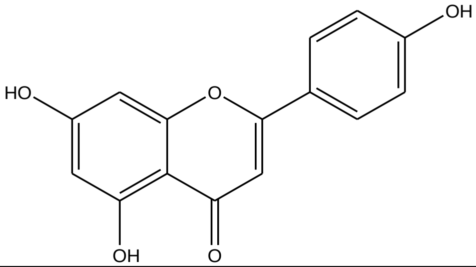
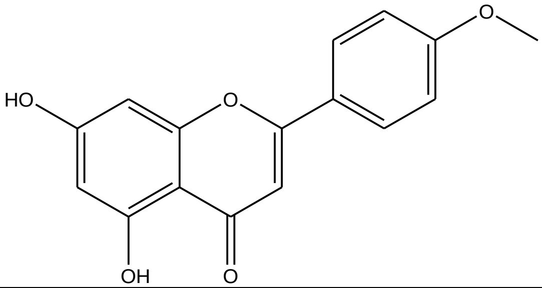
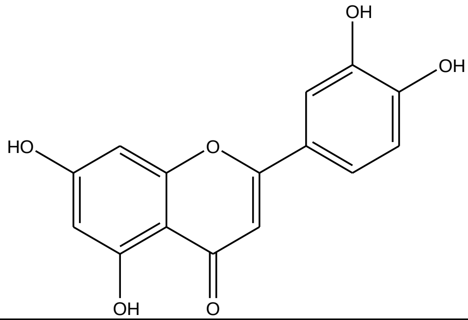
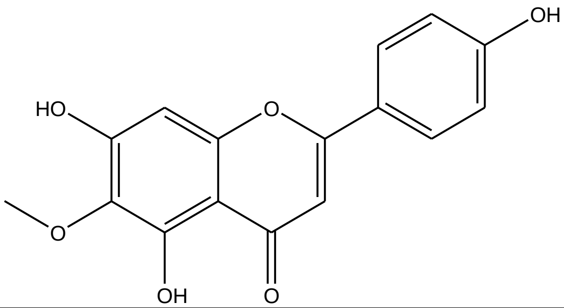
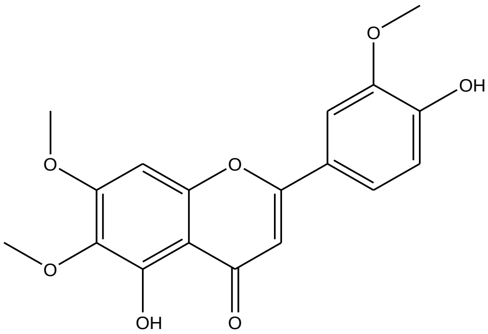
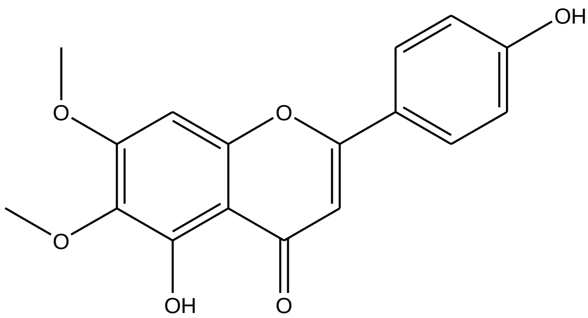
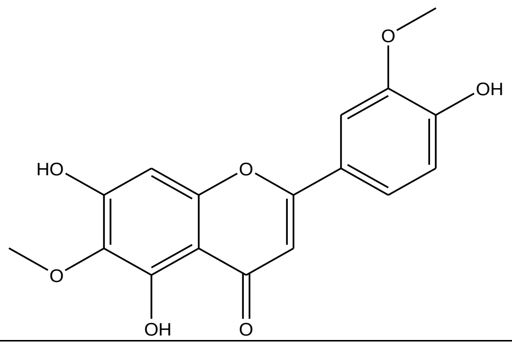
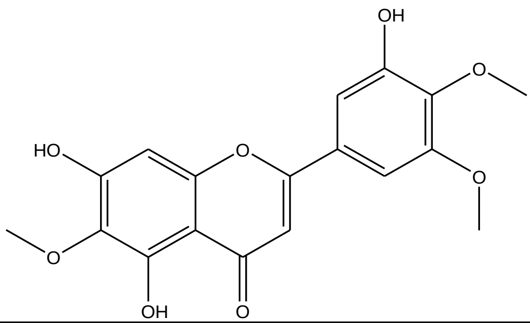
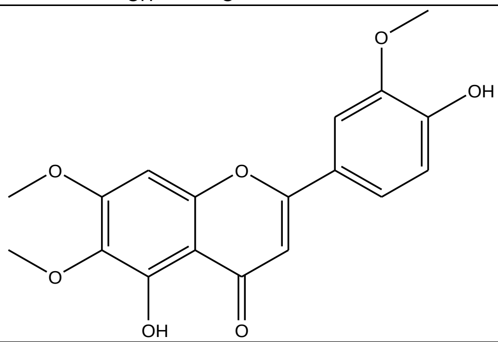
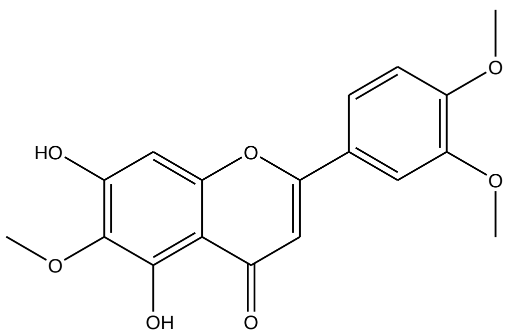
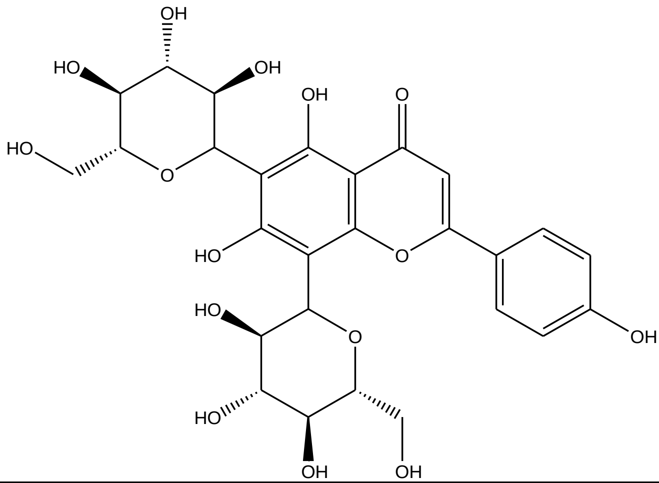
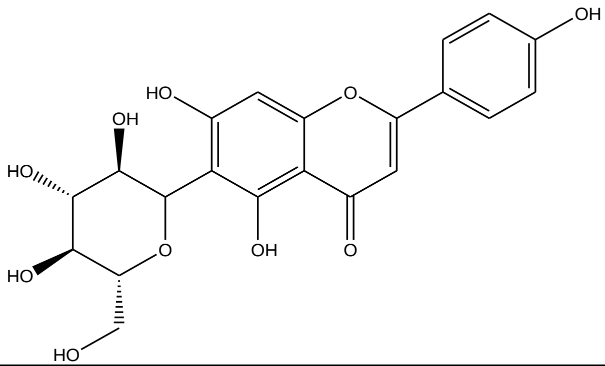
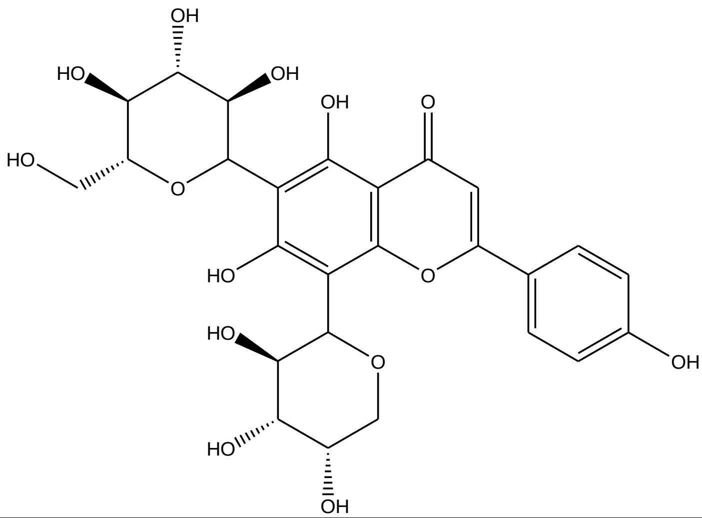
α-Terpineol		(Sanz *et al*., 1990a)
Seco-thujene		(Ahmed *et al*., 1990)
7-Hydroxy-5,6-dehydro-4,5-dihydrolyratrol		(Ahmed *et al*., 1990)
2R,3S,6R-2,6-Dimethyl-3,6-epoxyoct-7-enoic acid		(Marco *et al*., 1994)
3R,4S,7R-3,7-Dimethyl-4,7-epoxynon-8-enoic acid		(Marco *et al*., 1994)

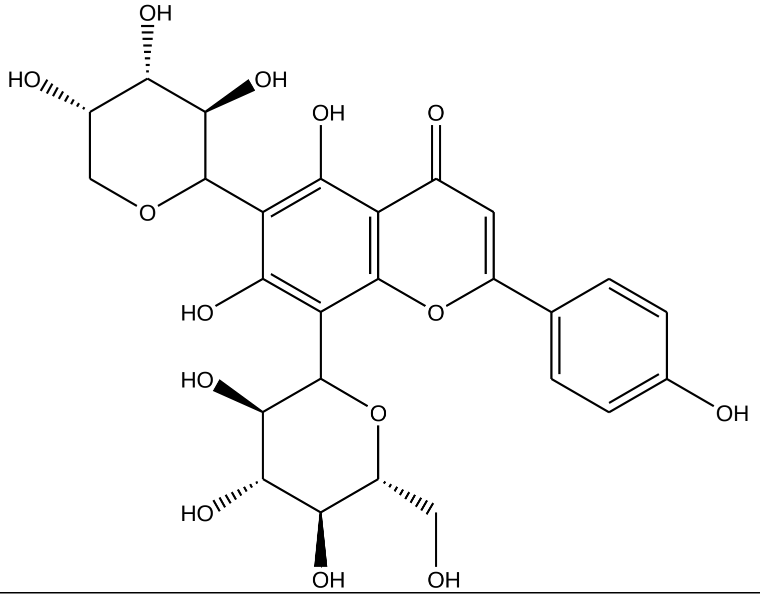
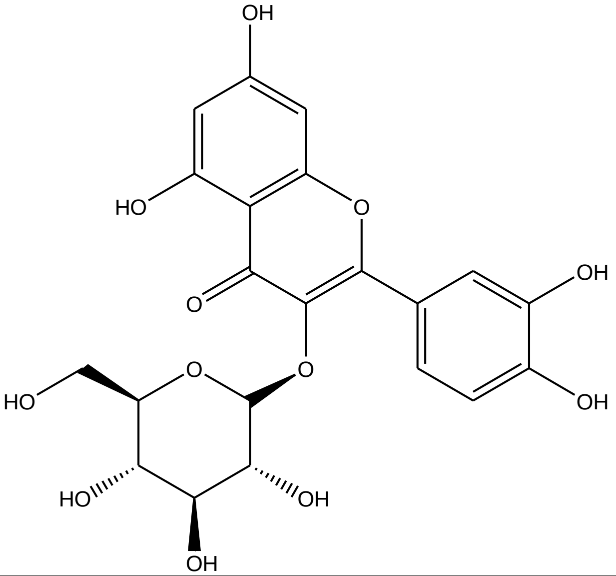
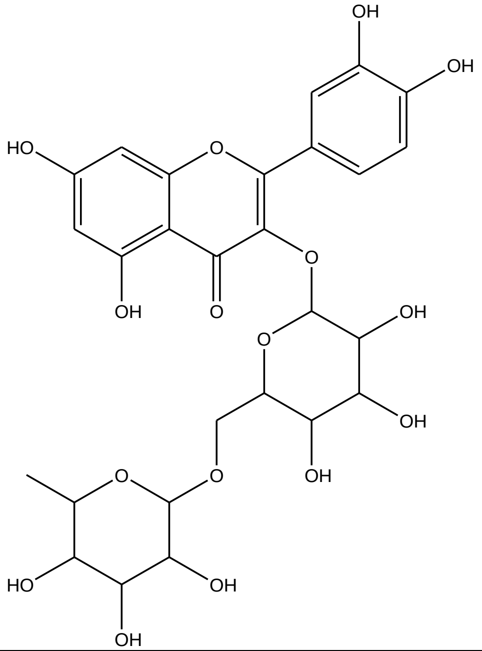
Table 3. Flavonoids and flavonoid glycosides

Compound name	**Compound structure**	**Reference**
Apigenin		(Saleh *et al*., 1987) (Awad *et al*., 2012)

Acacetin		(Saleh *et al*., 1987)
Luteolin		(Saleh *et al*., 1987)
Hispidulin		(Saleh *et al*., 1987) (Salah and Jager, 2005)
Cirsilineol		(Segal *et al*., 1973) (Saleh *et al*., 1987) (Salah and Jager, 2005)
Cirsimaritin		(Saleh *et al*., 1987)

Jaceosidin		(Saleh *et al*., 1987)
5,7,3'-Trihydroxy, 6,4',5'-trimethoxy flavone		(Saleh *et al*., 1987)
5,4'-Dihydroxy-6,7,3'-trimethoxyflavone		(Segal *et al*., 1973)
Eupatilin		(Qnais *et al*., 2014)

Vicenin-2		(Saleh *et al*., 1985) (Kim *et al*., 2004)
Isovitexin		(Saleh *et al*., 1985)
Schaftoside		(Saleh *et al*., 1985) (Kim *et al*., 2004)

Isoschaftoside		(Saleh *et al*., 1985) (Kim *et al*., 2004)
Quercetin-3-glucoside		(Saleh *et al*., 1985)
Quercetin-3-rutinoside (Rutin)		(Saleh *et al*., 1985) (Kim *et al*., 2004)

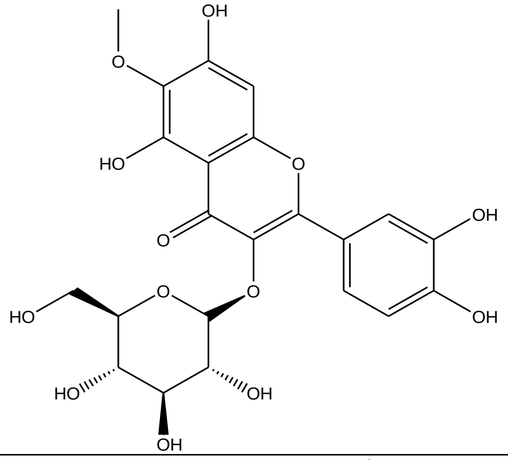
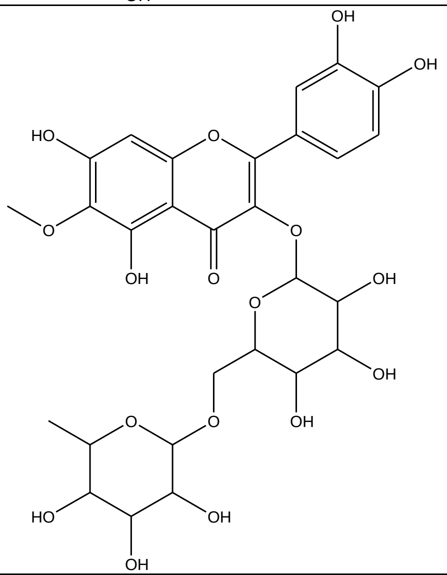
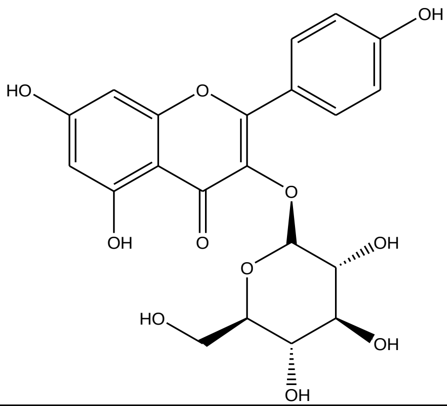
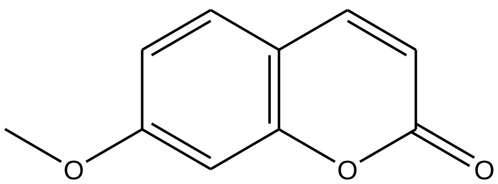
Patuletin-3-glucoside		(Saleh *et al*., 1985)
Patuletin-3-rutinoside		(Saleh *et al*., 1985)
Astragalin		(Qnais *et al*., 2014)

Table 4. Coumarins

Compound name	Compound structure	Reference
Herniarin		(Marco *et al*., 1994)

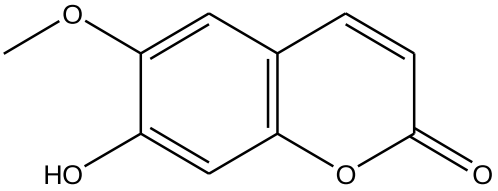
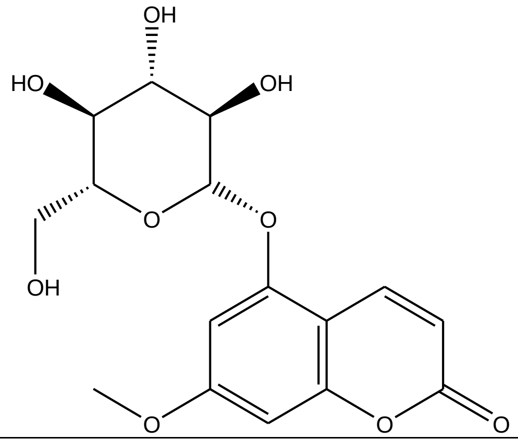
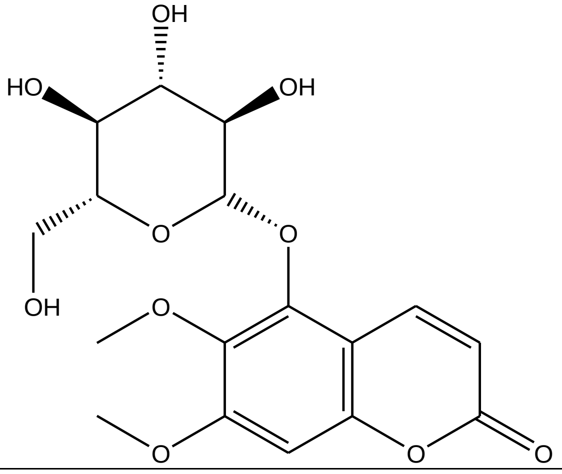
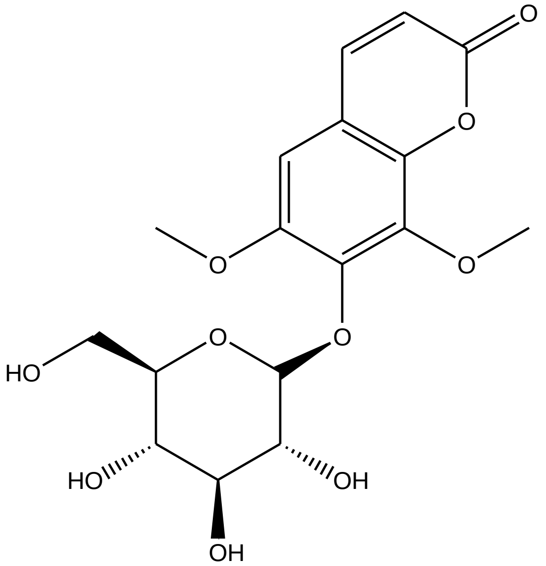
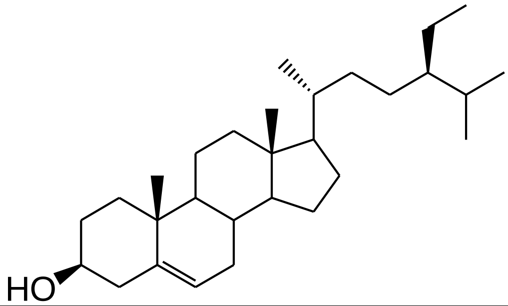
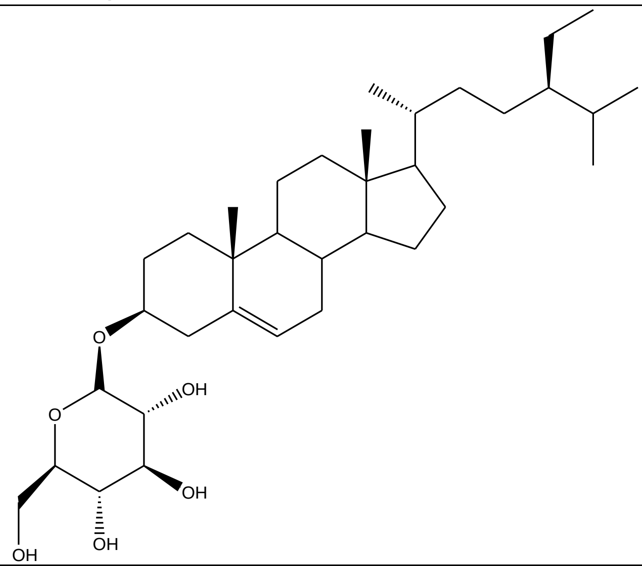
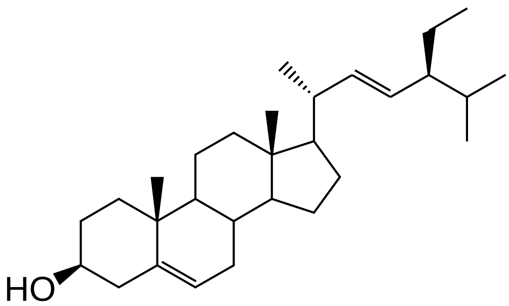
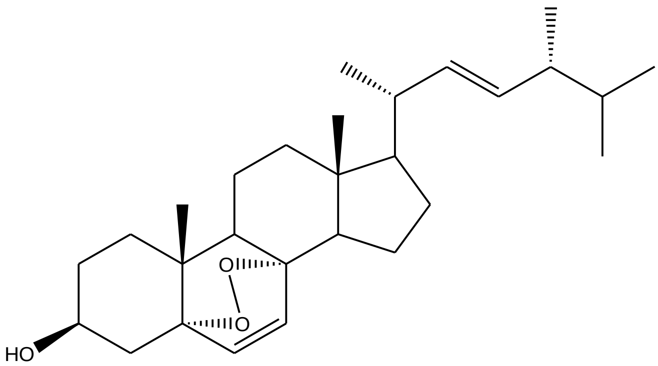
Scopoletin		(Marco, 1989)
5-β-D-glucopyranosyloxy-7-methoxy-6H-benzopyran-2-one		(Mohamed T. A. *et al*., 2019)
Tomenin		(Mohamed T. A. *et al*., 2019)
Isofraxidin-7-*O*-β-D-glucopyranoside		(Kim *et al*., 2004)

Table 5. Sterols and triterpenes

Compound name	Compound structure	Reference
β-Sitosterol		(Khafagy *et al*., 1971) (Awad *et al*., 2012)
β-Sitosterol 3-β-D-glucopyranoside		(Sanz *et al*., 1990a)
Stigmasterol		(Khafagy *et al*., 1971)
Ergosterol-5,8-endoperoxide		(Sanz *et al*., 1990a)

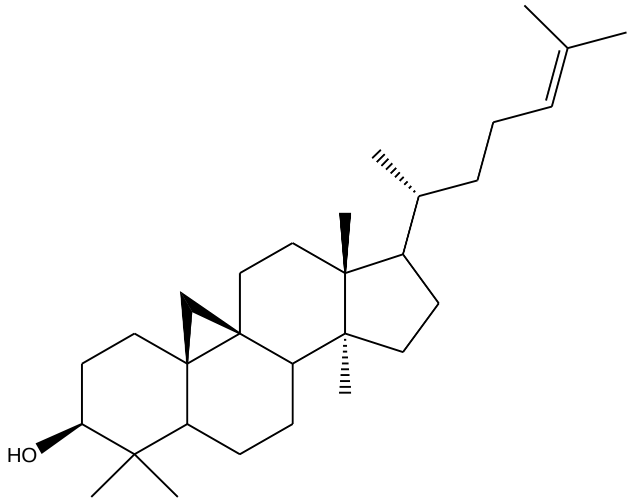
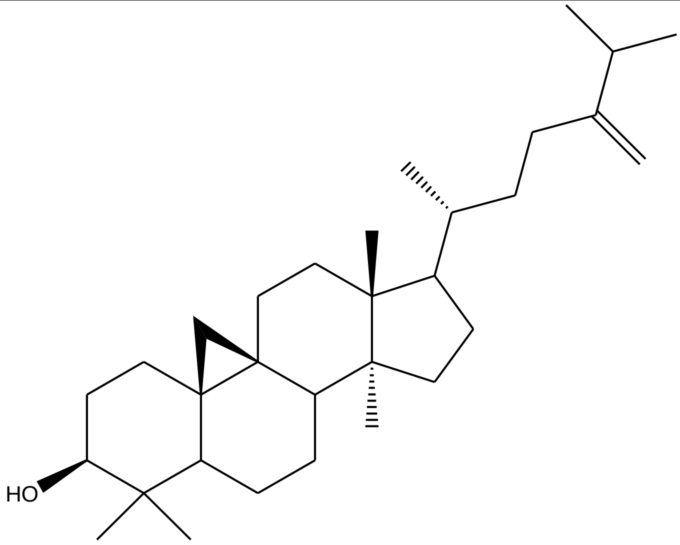
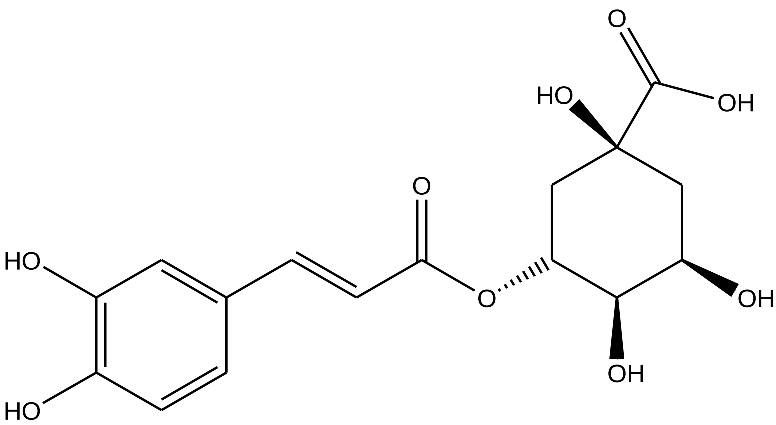
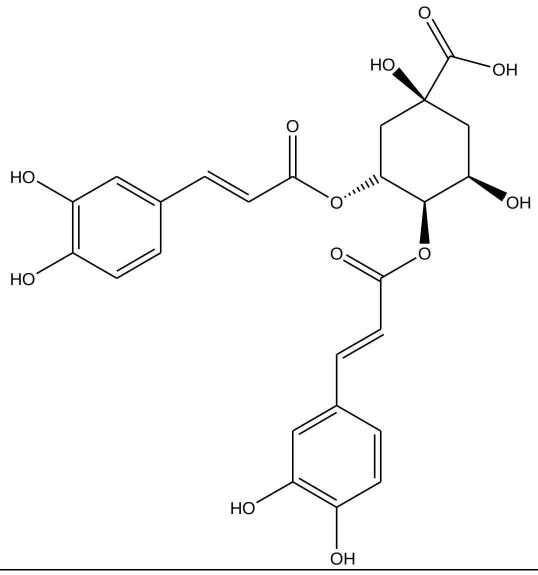
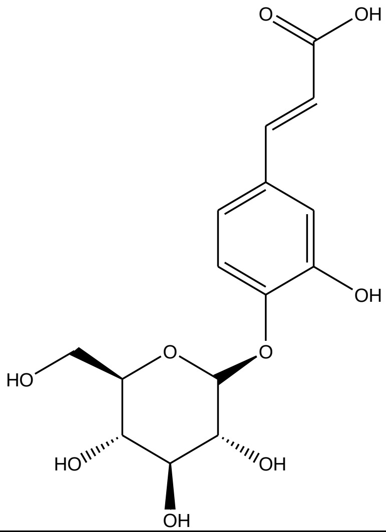
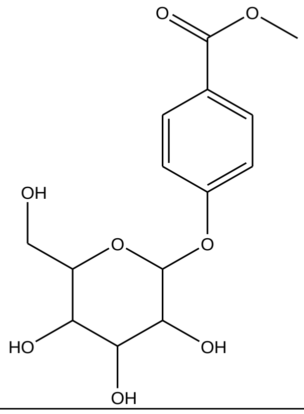
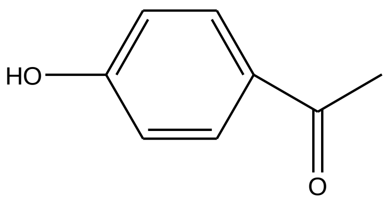
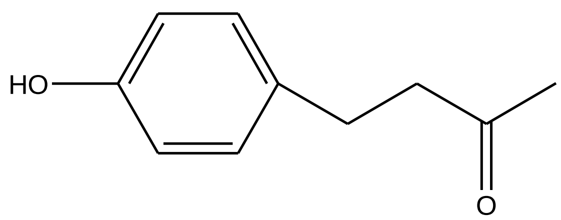
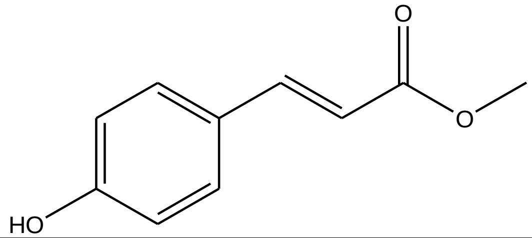
Cycloartenol		(Awad *et al.*, 2012)
24-Methylene cycloartenol		(Awad *et al.*, 2012)

Table 6. Miscellaneous compounds

Compound name	**Compound structure**	**Reference**
Chlorogenic acid		(Kim *et al.*, 2004)

4,5-*O*-dicaffeoylquinic acid		(Kim *et al.*, 2004)
4-*O*-β-D-glucopyranosylcaffeic acid		(Kim *et al.*, 2004)
Benzoic acid *p*-(β-D-glucopyranosyloxy) -methyl ester		(Mohamed *et al.*, 2019)
p-Hydroxyacetophenone		(Sanz *et al.*, 1990a) (Sanz *et al.*, 1990b) (Marco *et al.*, 1994)

4-(*p*-Hydroxyphenyl)-butan-2-one		(Ahmed *et al*., 1990) (Sanz *et al*., 1990b)
Methyl trans-*p*-coumarate		(Sanz *et al*., 1990b)

2.7. Essential oils:

Dob and Benabdelkader, 2006 reported the identification of 68 compounds in the essential oil of aerial parts of Artemisia herba-alba grown in Algeria using capillary GC and GC/MS methods. The main chemical class of the oil was monoterpenoids and the main components of the oil were camphor (19.4%), trans-pinocarveol (16.9%), chrysanthenone (15.8%) and β-thujone (15%).

Tilaoui et al., 2011 pronounced the identification of 18 volatile compounds in the essential oil of the aerial parts of the plant cultivated in Morocco using GC/MS technique as verbenol (21.83%), bisabolone oxide (17.55%) and farnesene epoxide (17.08%) were the main components of the oil.

Tilaoui et al., 2015 reported that the constitution of essential oil of Artemisia herba alba differed according to the plant part as oxygenated sesquiterpenes and monocyclic monoterpenes represented the main chemical classes in capitulum oil with a percentage of 22.86 and 21.48%, respectively. Stem oil contained mainly esters (62.8%) while leaves and aerial parts oil constituted of oxygenated sesquiterpenes with a percentage of 39.89 and 46.15%, respectively.

Kadri et al., 2011 reported that GC/MS analysis of the essential oil of Artemisia herba alba grown in south west Tunisia revealed the presence of α-thujone (24.88%), germacrene D (14.48%), camphor (10.81%), 1,8-cineole (8.91%) and β-thujone (8.32%) as the major constituents of the oil.

Awad *et al*., 2012 reported that geranyl N-butyrate (26.72%), germacrene B (17.25), 9-Octadecenal (14.38%) and Nerolidol (7.59%) were the major components of the essential oil of the plant grown in Egypt.

Aziz *et al*., 2012 reported that the major components of the oil of the aerial parts of the plant were chrysanthenone (30.6%), camphor (24.4%), camphene (4.5%), filifolone (4.3%), 1,8-cineole (3%), β-thujone (2.7%), α-thujone (2.4%) and α-pinene (2%).

Jaouadi *et al*., 2014 reported that the major components of the essential oil of the aerial parts of the plant were α-thujone, cis-sabinol, β-thujone, chrysanthenyl acetate, 1,8-cineole, chrysanthenone and *p*-cymene. They also reported that the constitution of the essential oil slightly differed according to the harvest period (December and May which represent floral and seed stages, respectively).

Younsi *et al*., 2016 reported that GC/MS analysis of the essential oil of the aerial parts of the plant grown in Tunisia led to identification of 23 compounds as β-thujone (41.9%), α-thujone (18.4%) and camphor (13.2%) were the major components of the oil.

Aloui *et al*., 2016 revealed that the main components of the essential oil of the aerial parts of the plant grow in Tunisia were camphor (36.82%), 1,8-Cineole (13.85%), chrysanthenone (8.8%), α-thujone (7.65%) and β-thujone (7.21%) as oxygenated monoterpenes was the predominating class (85.79%).

Bertella *et al*., 2018 have analysed the essential oils of the plant grown in Algeria by GC/MS technique leading to identification of 19 compounds as camphor was the most predominant component with a percentage of 50.7%.

Jasim and El-Zayat, 2019 reported that GC/MS analysis of the aqueous and methanolic extract of aerial parts of the plant grown in Iraq indicated the presence of many constituents among them some essential oils as camphor, borneol, t-cadinol and geranyl isovalerate.

Amor *et al*., 2019 stated that cis-thujone, trans-thujone and vanillyl alcohol were the main constituents of the essential oil of *A. herba alba* cultivated in south west

Morocco as the essential oil was extracted by hydrodistillation then analysed by GC/MS method.

Benabdallah *et al*., 2022 reported that β-copaene (16.22%), limonene (14.56%), eucalyptol (14.49%) and camphor (13.74%) were the major components of the oil of the plant cultivated in north east Algeria.

Amkiss *et al*., 2022 reported the identification of 21 compounds using pressurized liquid extraction method followed by GC/MS analysis. Oxygenated sesquiterpenes and monoterpenes were the major chemical classes as camphor, hanphillin, alkhanin, α-thujone, β-thujone, 2,5- bornadione, α-santonin and anobin were the main components.

Diass *et al*., 2023 revealed the chemical composition of the essential oils of *Artemisia herba alba* grown in two regions in east Morocco using GC/MS method as 1,6-dimethylhepta-1,3,5-triene (36.44%), camphor (22.5%) and thujone (7.21%) were the major constituents of Jerada essential oil while camphor (55.31%), eucalyptol (14.64%) and camphene (9.95%) were the major components of Taourirt essential oil.

Houti *et al*., 2023 demonstrated that the yields and constitution of essential oils of the aerial parts of the plant cultivated in Morocco differ according to the time of collection (March, June and September). They also reported that the main constituents of the oils were chrysanthenone, cis chrysanthenyl acetate, α-thujone, β-thujone, camphor, 1,8-cineole, trans β-dihydroterpineol and davanone.

Abdelali *et al*., 2023 revealed that the main components of the essential oil of the aerial parts of the plant were davanone (48.84%), chrysanthenone (15.97%), camphor (14.84%) and eucalyptol (5.69%).

Dmour *et al*., 2024 reported that monoterpenoids was the major chemical class in the essential oil of the leaves of the plant cultivated in Jordan with a percentage of 71.9% as α-pinene was the most predominant component with a percentage of 17.2%.

Medjeldi *et al*., 2024 declared that GC/MS analysis of the essential oil of the plant growing in Algeria led to identification of 19 compounds as camphor (51.14%), 1,8-cineole (19.3%), camphene (6.9%) and chrysanthenone (5.68%) were the main components.

El Ouardi *et al*., 2024 reported that oxygenated monoterpenes as the main chemical class of the essential oil of the plant collected from different regions of Morocco as thujone and camphor were the main constituents.

Amara *et al*., 2025 declared that the essential oil extracted by hydrodistillation of the aerial parts of the plant then analysed by GC/MS contained 61 compounds as camphor, α-thujone, β-thujone, 1,8-cineole and chrysanthenone were the predominant compounds.

Abdallah *et al*., 2025 reported that GC/MS analysis of *Artemisia herba alba* cultivated in Egypt revealed that oxygenated monoterpenes was the major class of volatile compounds with a percentage of existence 63.48%. Camphene, cis-chrysanthenyl acetate, trans-chrysanthenyl acetate sabinene, cis-piperitol and cis-pinocarveol were the major volatile oils.

Baranova *et al*., 2025 reported that camphor (26.02%), α-thujone (9.60%), β-thujone (8.38%), 1,8-cineole (8.02%), piperitenone (5.29%) and camphene (4.95%) were the major compounds of the essential oil of the plant cultivated in north west Tunisia.

Bsharat *et al*., 2025 reported that GC/MS analysis of the essential oil of leaves revealed the major constituents of the oil as 1,8-cineole (28.67%), trans-thujone (24%), cis-thujone (17.69%), camphor (12.76%) and terpinen-4-ol (8.34%).

3. Conclusion:

This review revealed the presence of several compounds in *Artemisia herba alba* including sesquiterpenes, sesquiterpene lactones, monoterpenes, monoterpene alcohols, flavonoids, flavonoid glycosides, sterols, coumarins, essential oils and many miscellaneous compounds reflecting the chemical diversity and richness of the plant.

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