J. Phytomol. Pharmacol., 1(1), 3-18, 2022
https://doi.org/10.56717/jpp.2022.v01i01.002
ISSN: 2957-5818

Journal of Phytomolecules & Pharmacology

Review Article

Botany and phytochemistry of *Adenanthera pavonina* L (Rakta Kambal)-A mini review

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Abstract

The plant *Adenanthera pavonina* L. (Leguminosae) is a traditionally and pharmacologically important medicinal plant of the Asian subcontinent. Various parts of the plant particularly seeds, roots and leaves are traditionally used for the treatment of rheumatism, inflammations, diarrhoea, boils and lowering of blood pressure. A critical phytochemical survey was executed on the phytochemistry of *A. pavonina*, and found a plethora of phytochemicals that consisted of various phytochemical groups namely phytosterols, saponins and sapogenins, flavonoids, alkaloid, alcohols, hydrocarbons, fatty acids and ester, carbohydrates, sugars and amino acids. Current phytochemical studies reveal the presence of 71 isolated compounds, a few of which have been shown different pharmacological activities. This review compiles a wealth of information on the phytochemistry of *A. pavonina* from the standpoints of chemistry and medicine that would be explored in order to carry on future research in the discovery and development of new therapeutic lead drug molecules.

Article Information
Received: 14 April. 2022
Revised: 2 June, 2022
Accepted: 12 June, 2022

Academic Editor:
Lina Trabelsi

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Keywords:
Adenanthera pavonina, aridanin, botany, oleanane type, phytochemistry, phytosterols, pavonin, flavonoids.

1. Introduction

Adenanthera pavonina L. is an important medicinal plant for its divers pharmacological properties especially of its leaf, bark and seed parts [1]. It belongs to the sub family Mimosaceae, of family Liguminosae (Fabaceae) and commonly known as red bead tree (Bengali: Raktakambal). *A. pavonina* is mostly endemic to Asian sub-continent, Southern China and India and almost found in Africa, Pacific and Caribbean regions [1-2]. Various parts of this plant have been known to be used in traditional medicines for the treatment of diarrhea, asthma, gout, boil, inflammations, rheumatism, haematuria, haematemesis, and as a tonic with potential pharmaceutical evidence such as anti-inflammatory, cytotoxic, analgesic, antibacterial, antifungal, antioxidant, antidiabetic, and blood pressure lowering activities [3-10]. A critical and comprehensive literature reviews on the phytochemical investigations of *Adenanthera pavonina* L. revealed that a number of important classes of compounds present in the plant. The compounds included flavone, flavanone, saponins, glycosides, steroids, fatty and amino acids [12-22]. In addition, the different parts of *A. pavonina* L. have reported very important compounds like pavonin, robenetin, butin, ampelopsin, apigenin, isoliquiritigenin, daucosterol, β-sitosterol glucoside, oleanolic acid, stigmasterol, echinocystic acid, aridanin, 3-[(2'-acetamido-2'-deoxy-β-D-Glucopyranosyl)-oxy)-16-α-hydroxyolean-12-en-28-oic acid, pinitol, sucrose, dulcitol, squalene, quebrachitol, octacosanol, chalcone, etc [11-22]. The survey showed that it contains interesting phytochemicals with potent pharmacological effect. There is no critical review has been published on the phytoconstituents and botanical features of *A.*

pavonina. Hence, our aim of the review is to decipher potential phytoconstituents of this plant part that might be open up new drug discovery way for the lead drug molecules.

1.1 General Description of the plant *Adenanthera pavonina* L.

1.1.1 Botany of *Adenanthera pavonina* L.

A medium to large sized deciduous tree. *A. pavonina* ranges in height from 6-15 m. with diameter up to 45 cm. depending upon location. The tree is generally erect, young parts glabrous and a spreading crown. The plant is shown in Fig. 1.

Bark is dark brown to grayish in colour. Multiple **stems** are common, as are slightly buttressed trunks in older trees [1, 23].

Leaves are 2-pinnate, 20-30 cm long; petioles 5-10 cm. long; pinnae 3-6 pairs, opposite,7.5-15 cm. long, with a stalk 1.3-2 cm. long. The leaves are turns to yellow with aging. Leaflets alternate, 4-8 pairs, 2.5-3.8 by 0.8-2 cm., papery, elliptic-oblong, obtuse, glabrous, dark green above, glaucous beneath, base shortly cuneate, unequal–sided; petiolules 3mm. long [1, 23].

Flowers are in short-peduncled racemes 5-15 cm. long, axillary or panicled at the ends of the branches; pedicels 2.5-3 mm. long, slender. They are small, creamy-yellow in colour, and fragrant. Calyx minute; lobes short, triangular. Corolla pale yellow about 3mm long; segments united at the base only, linear–lanceolate, acute, valvate. Stamens 10, free, hardly exserted; anthers gland-crested, pods 15-23 by 1.6-2 cm., flat, falcately curved, pointed, tapering to the base, the valves spirally twisted after dehiscence [1, 23].

Seeds are 8-15 lenticular–globose, with a blunt keel, smooth, shining, usually brilliant scarlet. The hard coated seeds are 7.5-9.0 mm in diameter, are lens shaped. The ripened pods remain on the tree for long periods and may persists until the flowering spring. There are reportedly 1600 seeds per pound [1, 23].

1.1.2 Synonyms of *Adenanthera pavonina* L.

The synonyms are [24]:

1. *Adenanthera gersenii* Scheffer.
2. *Adenanthera microsperma*
3. *Adenanthera microsperma var. luteosemiralis*
4. *Adenanthera pavonina var. luteosemiralis*
5. *Adenanthera pavonina var. microsperma*

1.1.3 Scientific classification of *Adenanthera pavonina* L. [1]:

Sub-Kingdom	:	Phanerogamia
Division	:	Angiospermia
Class	:	Dicotyledons
Sub-Class	:	Archichlamydeae
Order	:	Rosales
Family	:	Liguminosae (Fabaceae)
Subfamily	:	Mimosaceae
Genus	:	*Adenanthera*
Species	:	*Pavonina*

Botanical Name : *Adenanthera pavonina* L

1.1.4 Vernacular name of *Adenanthera pavonina* L. [1]

Bengali	Ranjana, Raktakambal, Raktakanchan
Andamans	Recheda
Assam	Chandan
Burma	Ywaygyee, Ywegyi
Canarese	Manjadi, Manjatti, Munjuti
Ceylon	Bead Tree
Deccan	Barigumchi, Hattigumchi
English	Bead tree, Coral bean tree, Peacock flower –fence, Sandalwood tree Redbead tree, Red wood.
French	Bois de bouclier, Condori, Condori commun, Condori, crete de paon, Condori glabre, Crete de paon
Gold Coast	Bead Tree, Peacock Tree, Red Sandalwood
Gujerati	Badigumchi, Barigumchi, Hattigumchi, Ratanjali, Rataval
Hindi	Barigumchi, Raktachandana
Konkani	Odlygunji
La Reunion	Bois noir rouge
Magahi	Gung
Malay	Kanduri bantang, Saga.
Philippines	Alalangat
Sanskrit	Ksharaka, Kusandana, Ranjaka, Thamraka,
Tamil	Anaikundimani, Manjadi, Sem, Tilagam, Tilam
Telugu	Bandigurivenda, Bandiguruginja, Enugaguruginji, Gurivenda, Peddaguriginja.

1.1.5 Ecology

This species is common throughout the lowland tropics up to 300-400 m. *Adenanthera pavonina* L. is a secondary forest tree favoring precipitation ranging between 3000-5000 mm for optimal growth. Found on a variety of soils from deep, well-drained to shallow and rocky, this tree prefers neutral to slightly acidic soils. Initial seedling growth is slow, but rapid height and diameter increment occur from second year onward. The tree is susceptible to breakage in high winds, with the majority of damage occurring in the crown [1].

Fig. 1.: Different parts of *Adenanthera Pavonina* L.

1.2 Medicinal importance of the plant *Adenanthera pavonina* L.

Leaves and Barks:	Decoction of leaves and bark are used as a remedy for chronic rheumatism, gout, haematuria and haematemesis. It also acts as aphr-odisiac and Anti–inflammatory and shows acute toxicity activity [1-3, 8, 25].
Seeds:	Decoction of seeds is used in pulmonary affections and chronic ophthalmia. They are also used for treatment of cholera and general paralysis. Powdered seeds hasten suppuration of boils and inflammations. The seed and its extract have anti–inflammatory, acute toxicity and blood pressure lowering effect [1-3, 8, 25].
Roots:	It is used as emetic. Methanolic extract (10%) of the roots lowers blood pressure up to 65% and enhances respiration up to 100% [1-3, 8, 25].

2. Materials and methods

Updated phytochemical and botanical information of *A. pavonina* was composed with the main keywords *A. pavonina*, activity of Adenanthera, isolation, traditional use and botany of *A. pavonina* etc. SciFindern, GoogleScholar® and Scopus® were used as electronic search engines. We have considered only phytochemistry and botany related articles which complies with the aim of the present review.

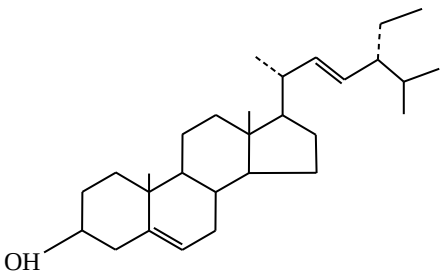
3. Results and Discussion

3.1 Phytochemical investigations of *Adenanthera pavonina L.*

The phytochemical survey identified of 71 compounds in total which are isolated from the *A. pavonina* L. The compounds consist of some classes, such as fatty acids and esters, sugars and amino acids, triterpenoid saponins and glycosides, alkaloid, long chain hydrocarbons, alcohols and amino compounds from the various parts of the plant. The reported compounds are summarized in Table 1 and the structures are shown inside the text with separate headings.

3.1.1 Terpenoids (Phytosterols)

Free stigmasterol **(1),** stigmasterol glucoside **(2)**, β-sitosterol **(3),** β-sitosterol glucoside **(4)** and α-spinasterol glucoside **(5)** were isolated from the leaves,



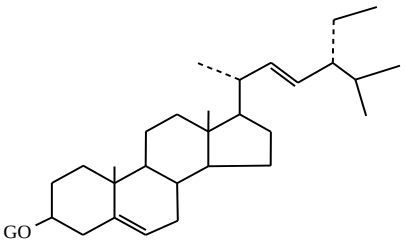
Stigmasterol **(1)**

seeds and seed kernels through chromatographic techniques [9, 13-14, 19]. In another separation from the bark extract, dichloromethane extract yielded stigmasta-5,22-dien-3β-ol **(6)** and 6-α-hydroxy stigmast-20(21)-en-3-one **(7)**, whereas stigmast–5(6), 20(21)-diene-3-one **(8)** was obtained from ethyl acetate extract [26].

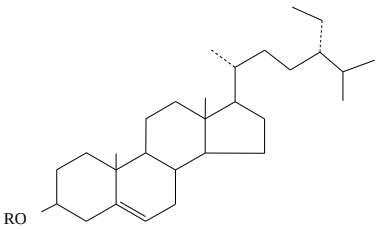
3.1.2 Triterpenoids (sapogenins and oleanane type saponins)

The triterpenoids sapogenins oleanolic acid (**9**) and echinocystic (**10**) acid were reported from the roots [17] and barks [19]. Recently, Mohamed et al., (2022) isolated 3-O-β-D-glucopyranosyl-23-O-β-D-glucopy ranosyl-3β, 11, 20, 22, 23-pentahydroxy-hopane (**11**)

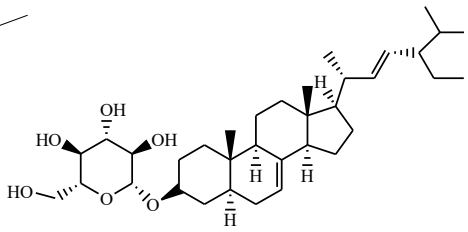
from the aqueous solution part of 70 ethanolic solution. [27]. On the other hand, oleanane type triterpenoids saponins aridanin (**12**) and 3-[(2-acetamido-2-deoxy-β-D-glucopyranosyl)-oxy)-16α-hydroxyolean-12-en-28-oic acid (**13**) were isolated from the ethanolic extract of the stems and leaves [28]. Later on Ara et al., 2020 isolated a few oleanane type triterpenoids 3-[(2'-acetamido-2'-deoxy- β-D-glucopyranosyl)oxy]-olean-12-en-28-oic acid (**14**), 3-[(2'-acetamido-2'-deoxy-β-D-glucopyranosyl)oxy]-16-α-hydroxyolean-12-en-28-oic acid (**15**) 3-O-β-D-glucopyranosyl-21-methylcarboxy-olean-12-en-28-oic-acid (16) and 3-O-β-D-glucopyranosyl-21-methyl carboxy-olean-18-en-28-oic acid (**17**) from the bark of the methanol extract [29]. In addition, a triterpenoid squalene (**18**) was also found in the leaves [21]



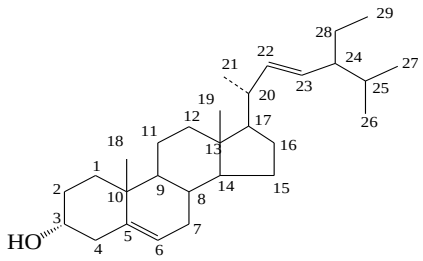
Stigmasterol glucoside (**2**)



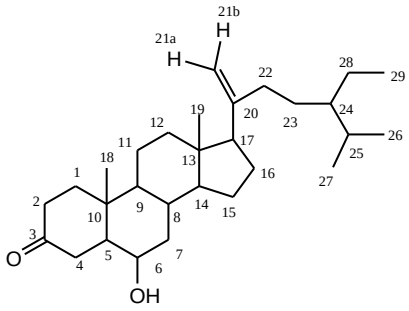
R=H β–Sitosterol (**3**)
R=Glc β–Sitosterol glucoside (**4**)



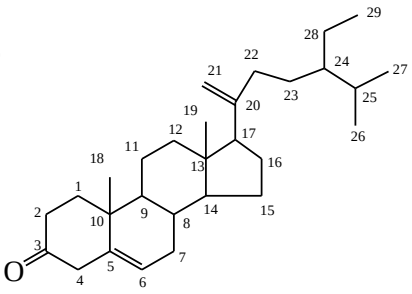
α-Spinasterol glucoside **(5)**



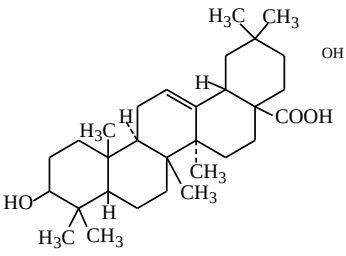
Stigmasta-5,22-dien-3-β-ol (**6**)



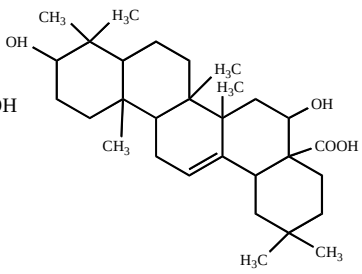
6-α-Hydroxy stigmast-20(21)-en-3-one (**7**)



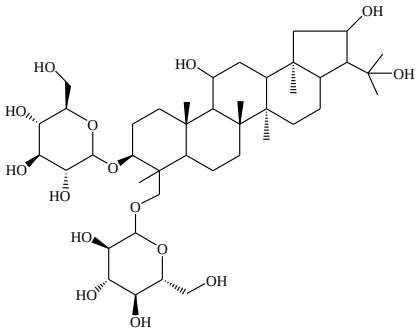
Sigmast-5(6), 20(21)-diene-3-one (**8**)



Oleanolic acid (**9**)



Echinocystic acid (**10**)



3-O-β-D-glucopyranosyl-23-O-β-D-glucopyranosyl-3β, 11, 20, 22, 23-pentahydroxy-hopane (**11**)

Table 1 Compounds isolated from the different parts of *Adenanthera pavonina* L.

Name of compounds	Plant parts/sources	References
Terpenoids (Phytosterols)		
Stigmasterol **(1)**	Seeds, leaves, seed kernel	[13] [9]
Stigmasterol glucoside **(2)**	Seeds, leaves, seed kernel, bark	[9, 13] [14, 19].
β-Sitosterol **(3)**	Seed kernel	[9]
β-Sitosterol glucoside **(4)**	Leaves , seed kernel	[9, 13]
α-Spinasterol glucoside (5)	Seed kernel	[9]
Stigmasta-5,22-dien-3β-ol **(6)**	Bark	[26].
6-α-Hydroxy stigmast-20(21)-en-3-one **(7)**	Bark	[26].
Stigmast–5(6), 20(21)-diene-3-one **(8)**	Bark	[26].
Triterpenoid sapogenins		
Oleanolic acid **(9)**	Bark, root	[14, 17].
Echinocystic acid **(10)**	Bark, root	[14, 17].
3-O-β-D-Glucopyranosyl-23-O-β-D-glucopyranosyl-3β, 11, 20, 22, 23-pentahydroxy-hopane **(11)**	Aerial part	[27]
Triterpenoids (oleanane type saponins)		
Aridanin **(12)**	Stems and leaves	[28]
3-[(2-acetamido-2-deoxy-β-D-Glucopyranosyl)-oxy)-16α-hydroxyolean-12-en-28-oic acid, **(13)**	Stems and leaves	[28]
3-[(2'-acetamido-2'-deoxy- β-D-glucopyranosyl)oxy]-olean-12-en-28-oic acid **(14)**	Bark	[29].
3-[(2'-acetamido-2'-deoxy-β-D-glucopyranosyl)oxy]-16-α-hydroxyolean-12-en-28-oic acid **(15)**	Bark	[29].
3-O-β-D-glucopyranosyl-21-methylcarboxy-olean-12-en-28-oic-acid **(16)**	Bark	[29].
3-O-β-D-glucopyranosyl-21-methyl carboxy-olean-18-en-28-oic acid **(17)**	Bark	[29].
Triterpenoid		
Squalene **(18)**	Leaves	[21]
Polyphenols/Flavonoids		
Robinetin **(19)**	Bark , wood	[14, 30]
Ampelopsin **(20)**	Bark, wood	[14, 30]
Butein **(21)**	Wood	[30]
Dihydrorobinetin **(22)**	Wood	[30]
Apigenin **(23)**	Stems and leaves	[28]
Isoliquiritigenin **(24)**	Stems and leaves	[28]
Isovitixin **(25)**	Seeds, Aerial part	[27, 31]
3,5,7,3',4'-Pentahydroxy flavone-3'-O-α-Lrhamnopyranosyl-(1→4)-O-α-L-arabinopyranosyl-(1→3)-O-β-D-xylopyranoside **(26)**	Seeds	[31]
2,4,7-Trihydroxyisoflavone **(27)**	Seeds	[31]
3,5,7,3',4'-pentahydroxy flavone **(28)**	Acid hydrolysis from compound 24	[31]
Quercetin 3-O-α-dirhamnopyranosyl-(1‴→2″, 1⁗→6″) -β-glucopyranoside-4′-methoxy **(29)**	Leaves	[32]

(continued on next page)

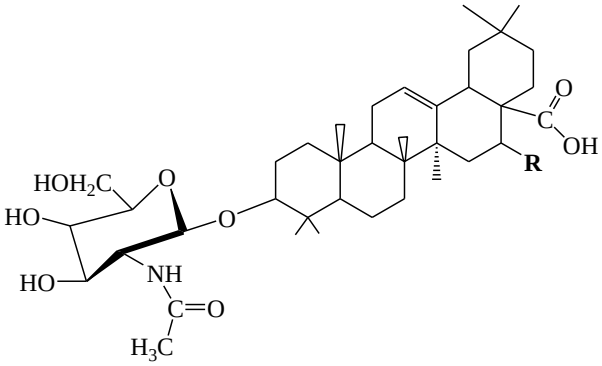
Table 1. (*Continued*)

Name of compounds	Plant parts/sources	References
Kaempferol-3-O-α-dirhamnopyranosyl-(1‴→2″,1⁗→6″)-β-glucopyranoside **(30)**	Leaves	[32]
Kaempferol-3-O-α-rhamnopyranosyl (1‴→2″)-β-glucopyranoside **(31)**	Leaves	[32]
Quercetin-3-O-rhamnopyranosyl(1‴→4″)-β-glucopyranoside **(32)**	Leaves	[32]
Quercetin-3-O-β-glucopranoside-4′-O-rhamnopyranoside **(33)**	Leaves	[32]
Quercetin-3-O-rhamnopyranosyl(1‴ → 2″)-β-glucopyranoside **(34)**	Leaves	[32]
Quercetin-3-O-β-glucopyranoside **(35)**	Leaves	[32]
Kaempferol **(36)**	Leaves	[32]
Quercetin **(37)**	Leaves	[32]
7-Methoxycatechin **(38)**	Bark	[29]
3-O-β-D-Glucopyranosyl-7-O-methyl catechin **(39)**	Bark	[29].
Tamarixetin 3-*O*-(α-L-rhamnopyranosyl)-(1→2)-β-D- xylopyranoside **(40)**	Aerial part	[27]
Quercetin 3-*O*-(α-L-rhamnopyranosyl-(1→2)-β-D xylopyranoside **(41)**	Aerial part	[27]
Quercetin-3-*O*-[α-L-rhamnopyranosyl-(1→2)]-[α-L-rhamnopyranosyl-(1→6)]-β-D-galactopyranoside **(42)**	Aerial part	[27]
Tamarixetin 3-*O*-(α-L-rhamnopyranosyl)-(1→2)-β-D-galactopyranoside **(43)**	Aerial part	[27]
Tamarixetin-3-O-[α-L-rhamnopyranosyl-(1→2)]-[α-L-rhamnopyranosyl-(1→6)]-β- D-galactopyranoside **(44)**	Aerial part	[27]
Quercetrin-3-O-α-L-rhamnopyranoside **(45)**	Aerial part	[27]
Quercetin 3-O-(2″-O-α-L-rhamnopyranosyl -6″-trans-p-coumaroyl)-β-D-glucopyranoside **(46)**	Aerial part	[27]
3-O-β-D-glucopyranosyl-23-O- β -D-glucopyranosyl-3 β, 11, 20, 22, 23-pentahydroxy-hopane **(47)**	Aerial part	[27]
Isoschaftoside **(48)**	Aerial part	[27]
Alkaloid		
3-Ethynyl, 5(2, 3-dehydropyrrole) pyridine **(49)**	Bark	[33]
Phenylpropanoids and polyketides		
Chalcone **(50)**	Bark, wood	[30]
Alcohols		
Dulcitol **(51)**	Leaves, seed kernel	[9, 13]
Octacosanol **(52)**	Leaves	[13]
Butin **(53)**	Bark	[14]**.**
Quebrachitol **(54)**	Leaves	[21]
n-Tricosanol (**55**)	Leaves	[34]
Ethyl 3, 3-dimethyl-13-hydroxytridecanoate **(56)**	Bark	[26].
18-(2′, 3′-dihydroxyphenyl) nonadec-17-en-2-ol **(57)**	Bark	[26].
Hydrocarbons		
Hentriacontane ($C_{31}H_{64}$) **(58)**	Leaves	[9, 21]
Nonacosane ($C_{29}H_{60}$) **(59)**	Leaves	[21]
Aliphatic amines		
1-(N-propyl amino)-2-henecosanone **(60)**	Bark	[26].

(continued on next page)

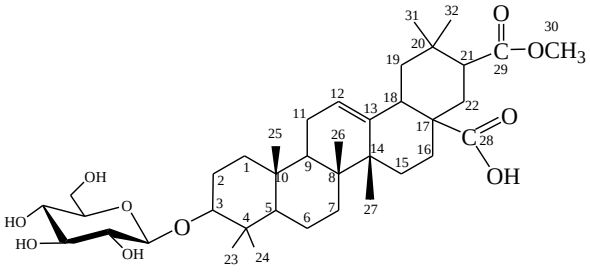
Table 1. (*Continued*)

Name of compounds	Plant parts/sources	References
Fatty acids and esters		
Lignoceric acid **(61)**	Seeds	[35]
2, 4-dihydroxybenzoic acid **(62)**		[30]
Ethyl palmitate (C_{18} $H_{36}O_2$) (**63**)	Leaves	[21]
Pavonin **(64)**	Aerial parts	[22].
Tert. butyl tridecanoate **(65)**	Bark	[26].
2-Hydroxy-1,2-diphenyl ethanone (benzoin) **(66)**	Bark	[29].
5-[1′,4′-dihydroxy-2′, 6′-dimethyl-6′-carboxy-2′-(2′′-methyl-succinyloxy) cyclohexyl]-3-methyl- 2E, 4E-Pentadienoic acid **(67)**	Aerial part	[27]
Methyl gallate **(68)**	Aerial part	[27]
Carbohydrates and Sugars		
Sucrose **(69)**	Stems and leaves	[28]
Pinitol **(70)**	Stems and leaves	[28]
α-D-Glucopyranosyl-(2→1')-α-D-glucopyranosyl-(6'→2' 2)-α-D-glucopyranosyl(6''→1', 2→2)-α-D-glucopyranoside **(71)**	Leaves	[34]

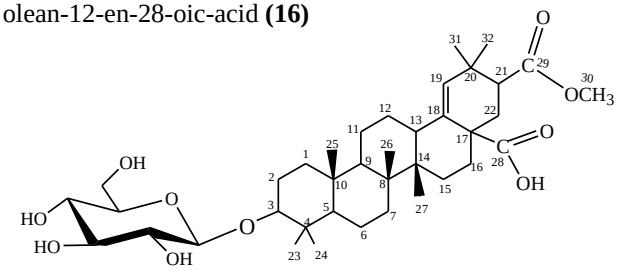


R = H 3-[(2-acetamido-2-deoxy-ß-D-Glucopyranosyl)-oxy)-olean-12-en-28-oic acid (aridanin) (**12**)

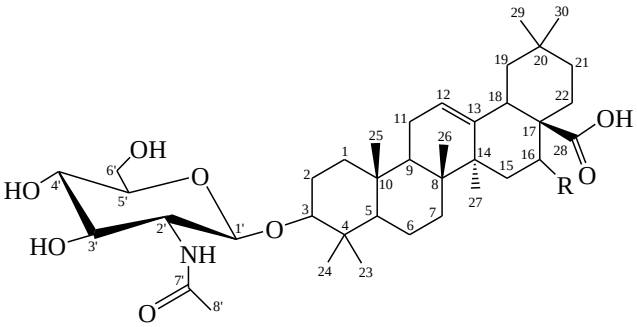
R = OH 3-[(2-acetamido-2-deoxy-ß-D-Glucopyranosyl)-oxy)-16 a-hydroxyolean-12-en-28-oic acid (**13**)



3-O-β-D-glucopyranosyl-21-methylcarboxy-olean-12-en-28-oic-acid **(16)**

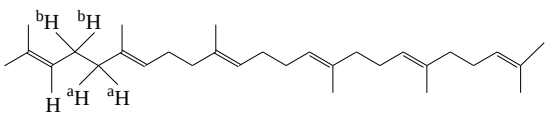


3-O-β-D-glucopyranosyl-21-methyl carboxy-olean-18-en-28-oic acid **(17)**



R = H, 3-[(2'-acetamido-2'-deoxy- β–D-glucopyranosyl) oxy]-olean-12-en-28-oic acid (**14**)

R = OH, 3-[(2'-acetamido-2'-deoxy-β-D-glucopyranosyl) oxy]-16-α–hydroxyolean-12-en-28-oic acid (**15**)



Squalene (**18**)

3.1.3 Polyphenols (Flavonoids)

A systematic chemical investigation on *A. pavonina* plant extract reported the presence of flavanoids robinetin **(19)**, and flavanol ampelopsin **(20)** from the bark [30]. Butein **(21)** and dihydrorobinetin **(22)** were produced in a methanolic extract of the wood of *A. pavonina* as well as robinetin **(19)**, and ampelopsin **(20)** [30]. Su et al., (2007) also isolated a flavone apigenin, **(23)** and a chalcone type isoliquiritigenin **(24)** from the ethanolic extract of the stems and leaves [28]. In another study, Yadava and Vishwakarma, (2013) isolated three compounds namely isovitixin **(25),** 3,5,7,3',4'-pentahydroxy flavone-3'-O-α-Lrhamnopyranosyl-(1→4)-O-α-L-arabinopyranosyl-(1→3)-O-β-D-xylopyranoside **(26)** and 2,4,7-Trihydroxyisoflavone **(27)** from the seeds of methanolic extract along with an acid hydrolysis compound 3,5,7,3',4'-pentahydroxy flavone **(28)** from the compound **26** [31]. In the following year, Mohammed et al., (2014) reported cytotoxic flavonoid compounds of 70% ethanol extract from the leaves of *A. pavonina* which were isovitixin **(25),** quercetin 3-O-α-dirhamnopyranosyl-(1‴→2″, 1⁗→6″)-β-glucopyranoside-4′-methoxy**(29),** kaempferol-3-O-αdirhamnopyranosyl-(1‴→2″, 1⁗→6″)-β-glucopyranoside **(30),** kaempferol-3-O-α-rhamnopyranosyl(1‴→2″)-β glucopyrano-side **(31),** quercetin-3-O-rhamnopyran-osyl(1‴→4″)-β-glucopyranoside **(32),** quercetin-3-O-β-glucoprano-side-4′-O-rhamnopyra-noside **(33),** quercetin-3-O-rhamnopyranosyl (1‴→2″)-β-glucopyranoside **(34),** quercetin-3-O-β-glucopyranoside **(35),** kaempferol **(36)** and quercetin **(37)** [32]. Later on, Ara et al., (2020) separated two flavonoids 7-methoxycatechin **(38)** and 3-O-β-D-glucopyranosyl-7-O-methyl catechin **(39)** from the methanol bark extract [29].

Recently, Mohamed et al., (2022) separated five flavonoid compounds: isovitixin **(25),** tamarixetin 3-*O*-(*α*-L-rhamnopyranosyl)-(1→2)-*β*-D- xylopyranoside (3) **(40),** quercetin 3-*O*-(*α*-L-rhamnopyranosyl-(1→2)-*β*-D-xylopyranoside **(41),** quercetrin-3-O-α-L-rhamnopyranoside **(45)** and quercetin 3-O-(2″-O-α-L-rhamnopyranosyl-6″-trans-p-coumaroyl)-β-D-glucopyranoside **(46),** all from the aerial parts of the ethyl acetate fraction partitioned from 70% methanol extract. The remaining flavonoids were isolated from the aqueous partitioned of the 70% methanol extract and yielded five compounds quercetin-3-*O*-[*α*-L-rham-nopyranosyl-(1→2)]-[*α*-L-rhamnopyranosyl-(1→6)]-*β*-D galactopyranoside **(42),** tamarixetin 3-*O*-(*α*-L-rhamnopyranosyl)-(1→2)-*β*-D-galactopyranoside **(43),** tamarixetin-3-O-[α-L-rhamnopyranosyl-(1→2)]-[α-L-rhamnopyranosyl-(1→6)]-β-D-galactopyranoside **(44),**3-O-*β*-D-glucopyranosyl-23-O-*β*-Dglucopyrano-syl-3 *β*, 11, 20, 22, 23-pentahydroxy-hopane **(47),** isoschaftoside **(48)** [27]

3.1.4 Alkaloid

In addition, the alcoholic extract of the leaves of *A. pavonina* showed the presence of an alkaloidal substance, melting point 88 ^{0}C [12]. Later on, 3-ethynyl, 5(2, 3-dehydropyrrole) pyridine (**49**) was isolated from the stem bark of the ethyl acetate fraction of ethanol extract [33].

3.1.5 Phenylpropanoids and polyketides

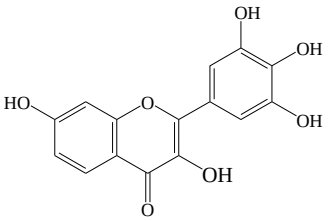
An aromatic homomonocyclic ketonic compound chalcone **(50)** known as retrochalcones was isolated and identified from the ethereal extract of the wood [30]

3.1.6 Alcohols

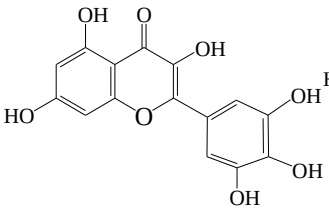
As the aim of isolation, Nigam et al ., (1973) isolated a sugar alcohols dulcitol **(51)** and a fatty alcohol octacosanol **(52)** along with other compounds from its leaves [13]. An aliphatic alcohol butin **(53)** was reported by Yadav et al., (1976) from the bark part [14]. Besides, the methanol extract yielded a pentahydroxy cyclic alcohol quebrachitol **(54)** from the leaves [21]. On the other hand, Mujahid et al., (2016) also discovered a fatty alcohol called n-tricosanol (**55**) in the methanolic extract of the leaves [34]. Later on, Ara et al., (2019) isolated an aliphatic alcohol ethyl 3,3-dimethyl-13-hydroxytridecanoate (**56**) from the dichloromethane extract and an aromatic alcohol 18-(2′, 3′-dihydroxyphenyl)nonadec-17-en-2-ol (**57**) from the ethyl acetate extract of the bark part [26].

3.1.7 Hydrocarbons

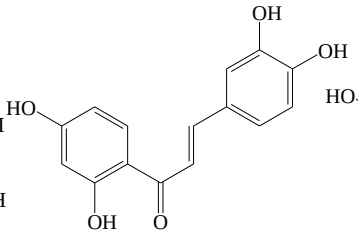
There are two hydrocarbons were isolated from the leaves of *A. pavonina.* Among these, hentriacontane ($C_{31}H_{64}$) (**58**) and nonacosane ($C_{29}H_{60}$) (**59**) were extracted from the leaves of chloroform extract [21]



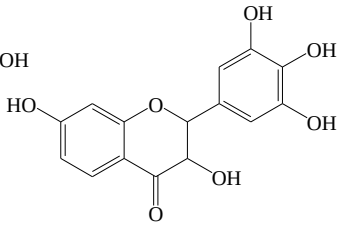
Robinetin **(19)**



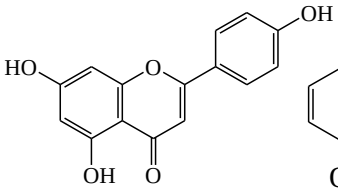
Ampelopsin **(20)**



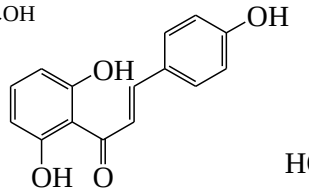
Butein **(21)**



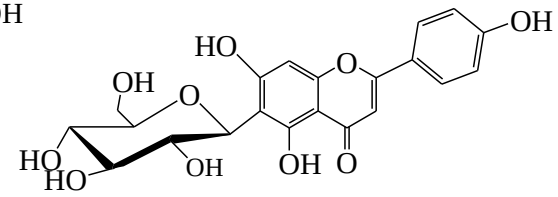
Dihydrorobinetin **(22)**



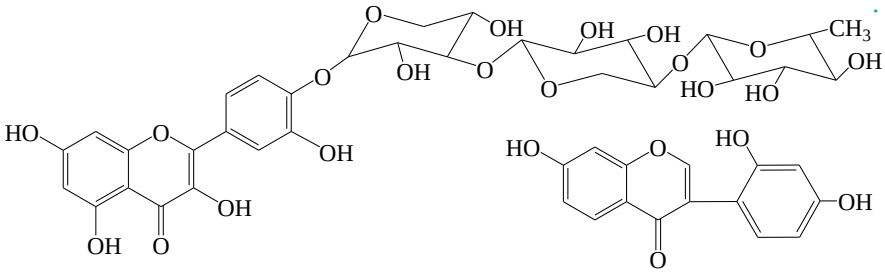
Apigenin **(23)**



Isoliquiritigenin **(24)**

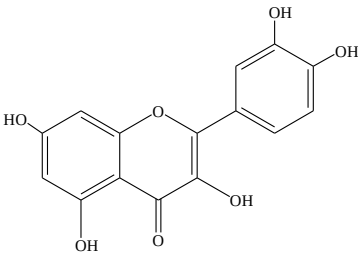


Isovitexin **(25)**

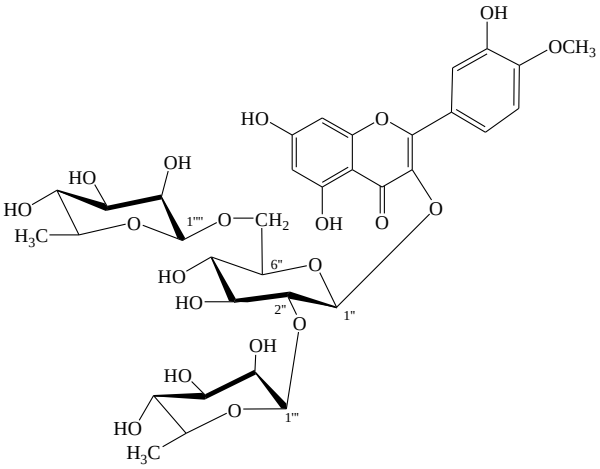


3,5,7,3',4'-pentahydroxy flavone-3'-O-α–L -rhamnopyranosyl-(1⟶4)-O-α-L-arabino-pyranosyl-(1⟶3)-O-β-D-xylopyranoside (**26**)

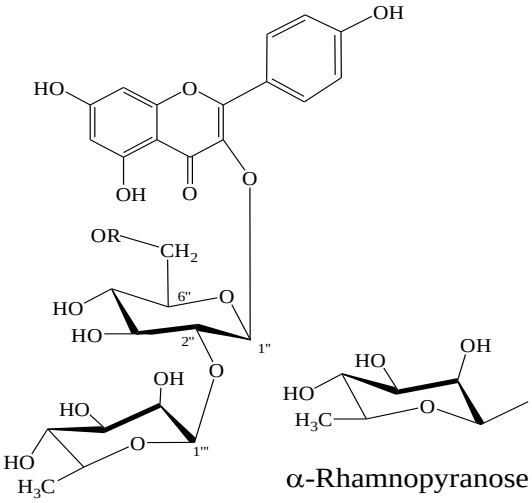
2,4,7-trihydroxyisoflavone (**27**)



3,5,7,3',4'-pentahydroxy flavone (**28**)



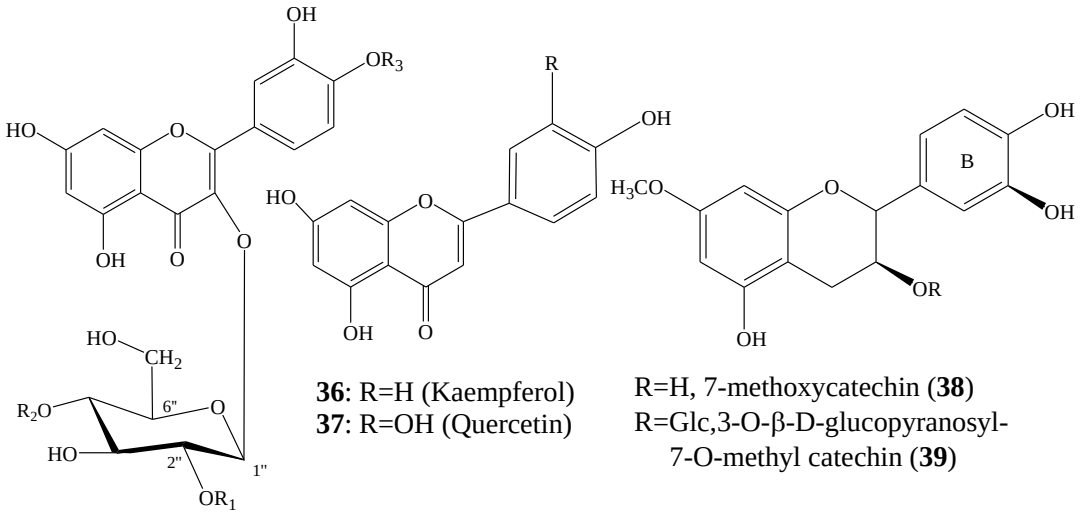
Quercetin 3-O-α-dirhamnopyranosyl-(1‴⟶2", 1⁗⟶6") -β-glucopyranoside-4'-methoxy **(29)**



α-Rhamnopyranose

30:R= α-Rhamnopyranose
31:R=H

Kaempferol-3-O-α-dirhamnopyranosyl-(1‴⟶2", 1⁗⟶6")-β-glucopyranoside **(30)**
Kaempferol-3-O-α-rhamnopyranosyl-(1‴⟶2"-β-glucopyranoside **(31)**

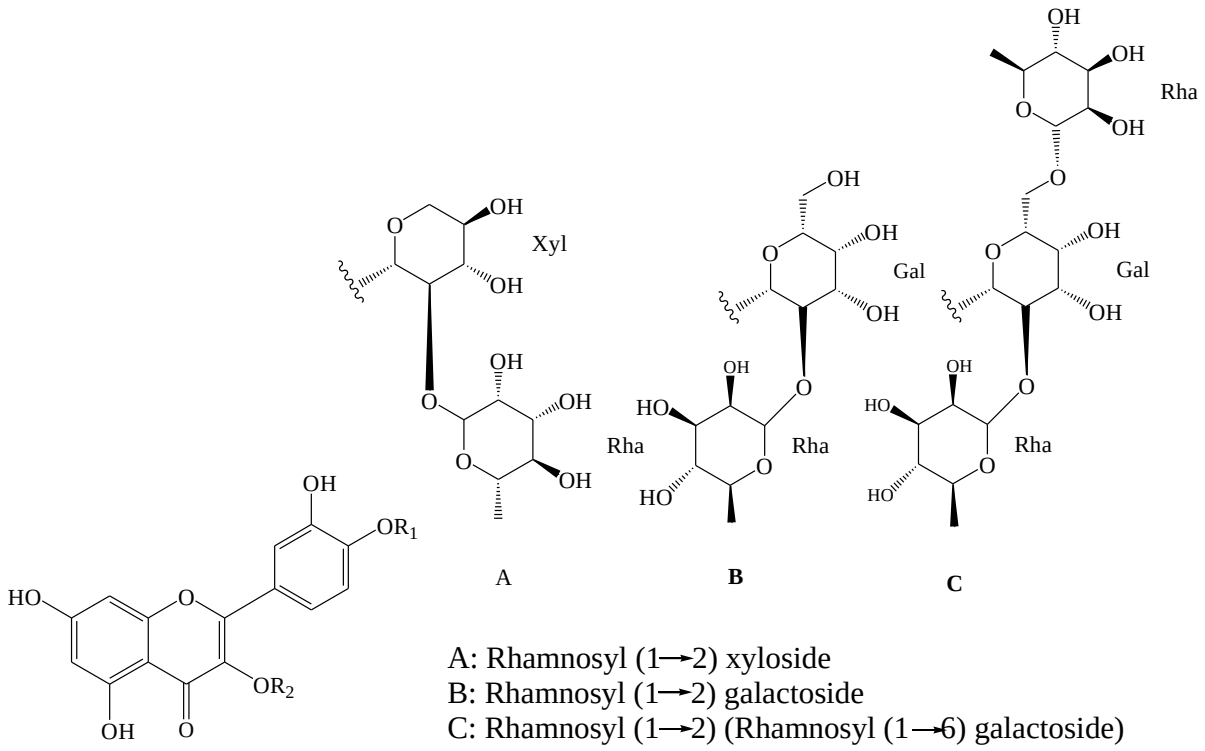


36: R=H (Kaempferol)
37: R=OH (Quercetin)

R=H, 7-methoxycatechin (**38**)
R=Glc,3-O-β-D-glucopyranosyl-7-O-methyl catechin (**39**)

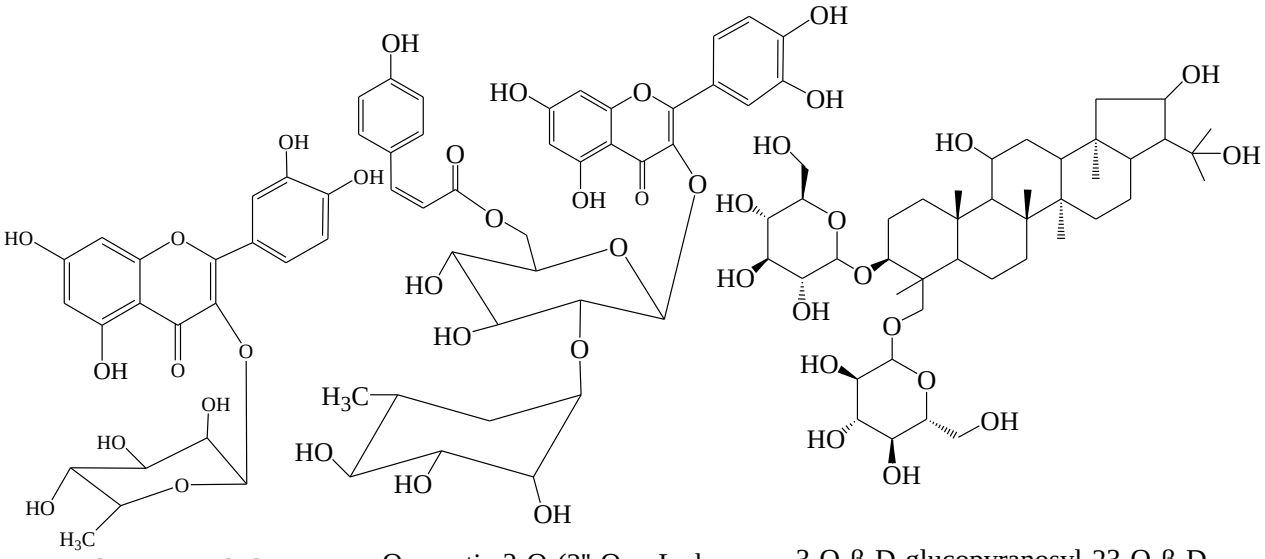
32:R_1= R_3=H, R_2=α-Rhamnopyranose
33:R_1= R_2=H, R_3=α-Rhamnopyranose
34:R_2= R_3=H, R_1=α–Rhamnopyranose
35:R_1= R_2=R_3=H

Quercetin-3-O-rhamnopyranosyl(1'''→4'')-β-glucopyranoside **(32)**
Quercetin-3-O-β-glucopranoside-4'-O-rhamnopyranoside **(33)**
Quercetin-3-O-rhamnopyranosyl(1'''→2'')-β-glucopyranoside **(34)**
Quercetin-3-O-β-glucopyranoside **(35)**



A: Rhamnosyl (1→2) xyloside
B: Rhamnosyl (1→2) galactoside
C: Rhamnosyl (1→2) (Rhamnosyl (1→6) galactoside)

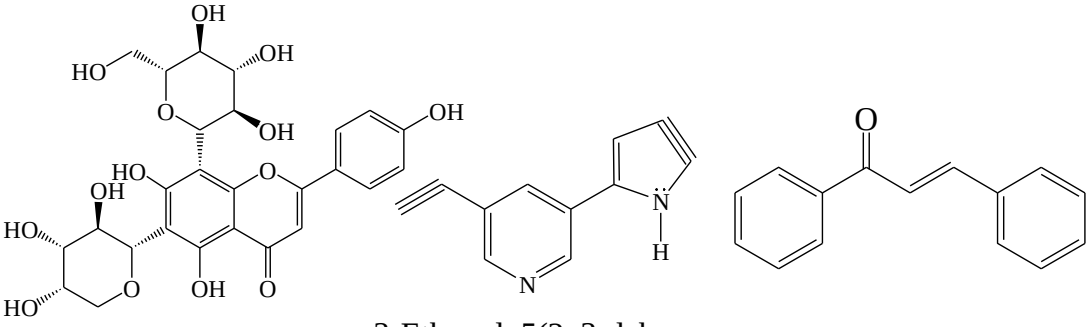
40 :R_1= CH_3, R_2=Rhamnosyl (1→2) xyloside
41 :R_1= H, R_2=Rhamnosyl (1→2) xyloside
42 :R_1= H, R_2=Rhamnosyl (1→2) (Rhamnosyl (1→6) galactoside)
43 :R_1=CH_3, R_2=Rhamnosyl (1→2) galactoside
44 :R_1=CH_3, R_2=Rhamnosyl (1→2) (Rhamnosyl (1→6) galactoside)



Quercetrin-3-O-α-L-rhamnopyranoside (**45**)

Quercetin 3-O-(2"-O-α-L-rhamnopyranosyl-6"-trans-p-coumaroyl)-β-D-glucopyranoside (**46**)

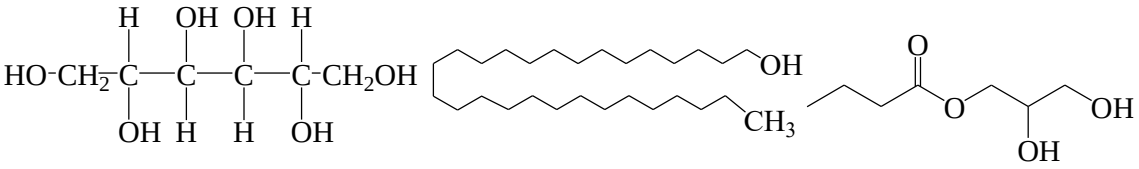
3-O-β-D-glucopyranosyl-23-O-β-D-glucopyranosyl-3β, 11, 20, 22, 23-pentahydroxy-hopane (**47**)



Isoschaftoside **(48)**

3-Ethynyl, 5(2, 3-dehydropyrrole)pyridine (**49**)

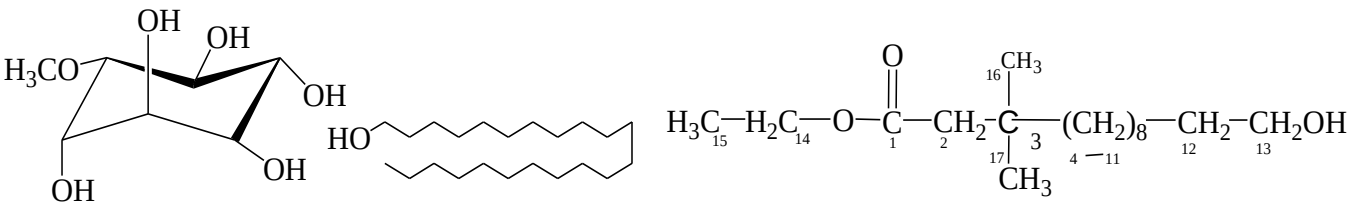
Chalcone **(50)**



Dulcitol (**51**)

Octacosanol **(52)**

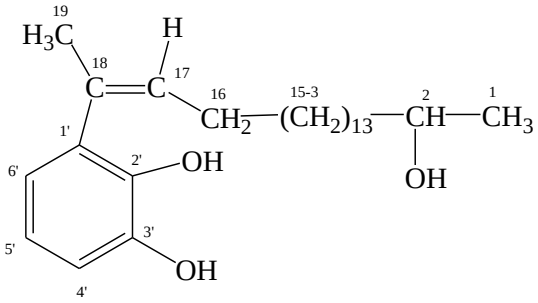
Butin **(53)**



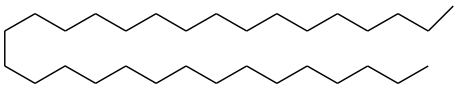
Quebrachitol **(54)**

n-Tricosanol **(55)**

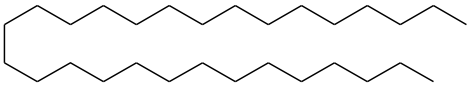
Ethyl 3,3-dimethyl-13-hydroxy tridecanoate (**56**)



18-(2' ,3' -Dihydroxyphenyl)nonadec-17-en-2-ol (**57**)



Hentriacontane ($C_{31}H_{64}$) **(58)**



Nonacosane ($C_{29}H_{60}$) **(59)**

3.1.8 Amino acids and aliphatic amine

The chemical analysis of *A. pavonina* identified various type of free amino acids such as valine , isoleucine, alanine, phenylalanine, aspartic acid, cystine , glutamic acid, glycine, leucin, lysine, methionine, proline, serine, histidine, arginine, tyrosine and reported [36]. Likewise, the amino acids methionine, lysine and tryptophan were also reported from the seed part [18]. In addition, protease and trypsin/chymotrypsin-trypsine inhibitors were isolated from the seed part [15, 16]. Besides, the cysteine and proteinase inhibitors were also isolated from seeds of *A. pavonina* [20]. According to the reported data, an aliphatic amino compound 1-(N-propyl amino)-2-henecosanone **(60)** was isolated from the ethyl acetate extract of the barks of *A. pavonina* [26].

3.1.9 Fatty acids and esters

The oil composition of the seeds has been reported to the presence of myristic, palmitic, stearic , arachidic , lignoceric, oleic, linoleic, linolenic, andoleic, octacosanoic and eicosanoic acid [11, 37]. In addition, lignoceric acid **(61)** which was separated from the seeds of fixed oil [35]. In addition, Misba et al., (1975) reported fatty acids: palmitic, stearic, arachidic, lignoceric, octacosanoic, oleic , linoleic and eicosanoic from its seed kernel [9]. In another investigation, an aromatic acid 2, 4-dihydroxybenzoic acid **(62)** was yielded from the ethereal extract of the wood as a major compound of the study [30]. Moreover, a long chain fatty acid ester, ethyl palmitate (C_{18} $H_{36}O_2$) **(63)** was separated from its chloroform extract of the leaves [21]. Subsequently, a new lactone (cyclic esters) pavonin **(64)** isolated from methanol extract of the aerial parts of *Adenanthera pavonina L* [22]. In the first study, Ara et al., (2019) isolated an alephetic carboxilic acid derivative tert. butyl tridecanoate **(65)** in the dichloromethane extract of the bark [26].

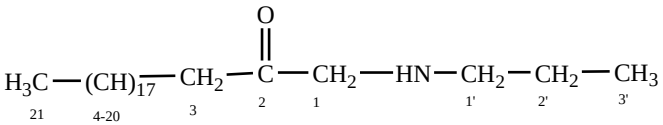
Further, a benzoic acid derivative 2-hydroxy-1,2-diphenyl ethanone (benzoin) **(66)** was discovered in the second experiment from the ethyl acetate fraction of methanolic bark extract [29]. Recently, Mohamed et al., (2022) isolated two ester derivatives 5-[1′,4′-dihydroxy-2′, 6′-dimethyl-6′-carboxy-2′-(2″-methyl-succinyloxy)cyclohexyl]-3-methyl-2E,4E- pentadieno-ic acid **(67)** and methyl gallate **(68)** from the aerial parts of the ethyl acetate fraction partitioned from 70% methanol extract [27]

3.1.10 Carbohydrates and Sugars

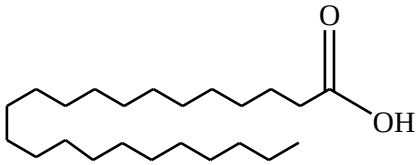
Analysis of reducing sugar, the seeds of *A. pavonina* contained, D-arabinose, D-glucose, D-rhamnose and D-xylose [36]. In the next year, Su et al., (2007) extracted sucrose **(69)** and pinitol **(70)** from the etha nolic extract of the stems and leaves [28]. As a part of the ongoing research on *A. pavonina,* α-D-glucopyranosyl-(2→1')-α-D-glucopyranosyl-(6'→2'2)-α-D-glucopyranosyl(6''→1',2→2)-α-D-glucopyran-oside **(71)** was isolated and identified as carbohydrate glycoside of the leaves of the methanolic extract [34]

3.1.11 Pharmacological importance of the isolated compounds

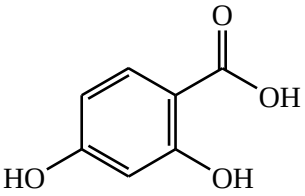
The pharmacological studies of the isolated compounds are very limited for *A. pavonina* after



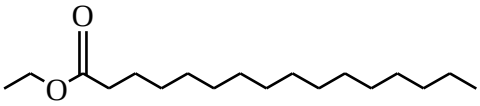
1-(N-propyl amino)-2-henecosanone (**60**)



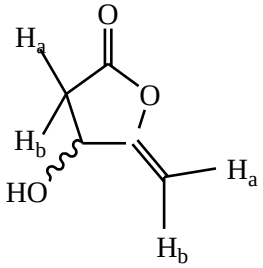
Lignoceric acid (**61**)



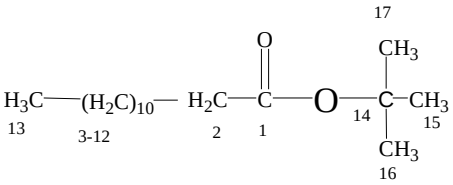
2, 4-Dihydroxybenzoic acid (**62**)



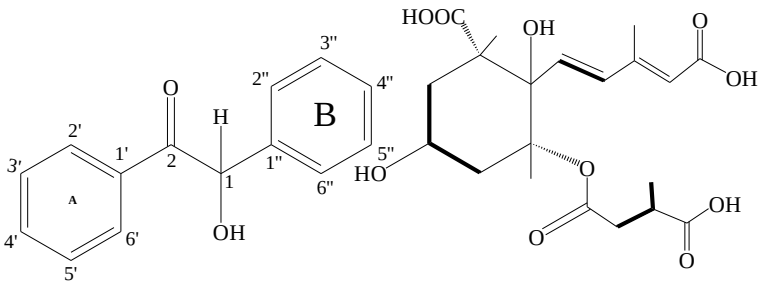
Ethyl palmitate **(63)**



Pavonin **(64)**

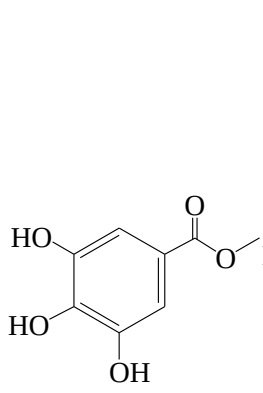


Tert butyl tridecanoate **(65)**

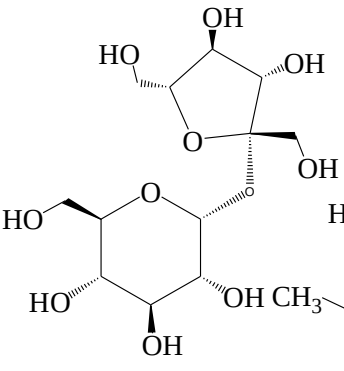


2-hydroxy-1,2-diphenyl ethanone (benzoin) **(66)**

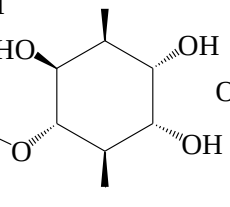
5-[1' ,4'-dihydroxy-2', 6'-dimethyl -6'-carboxy-2'-(2''-methyl-succi nyloxy) cyclohexyl]-3-methyl -2E, 4E-pentadienoic acid (**67**)



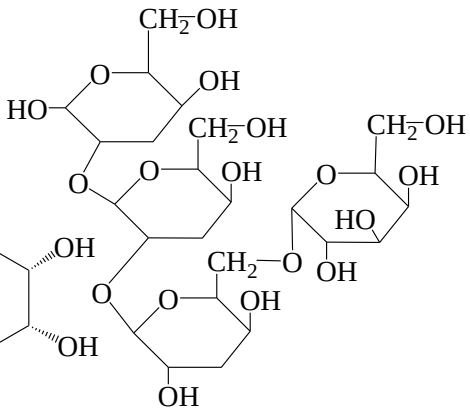
Methyl gallate (**68**)



Sucrose **(69)**



Pinitol **(70)**



α-D-glucopyranosyl-(2⟶1')-α-D-glucopyranosyl-(6'⟶2' -2) -α-D-glucopyranosyl(6''⟶ 1', 2⟶2)-α-D-glucopyranoside **(71)**

isolation. Nonetheless, a few compounds showed potential pharmacological effects. β-sitosterol glucoside **(4)** was isolated from the leaves of *A. pavonina* and showed potential antioxidant and hepatoprotection ability against CCl_4 induced liver injury rats [38]. In the investigation of antioxidant and antimicrobial activity, 3-ethynyl, 5(2, 3-dehydropyrrole) pyridine **(49)** showed potential activity against Gram-positive and Gram-negative bacteria as well as radical scavenging power [33]. In the case of cytotoxic activity, quercetin 3-O-α-dirhamnopyranosyl-(1‴→2″,1⁗→6″)-β-glucopyr-an-oside-4′-methoxy **(29)** reported the moderate activity on MCF7 and HepG2 cell lines that was isolated from the leaves [32] As the anti-inflammatory potentials, tamarixetin 3-*O*-(α-L-rhamnopyranosyl)-(1→2)-β-D-galactopyranoside **(43)** was the most effective at suppressing TNF-a protein and m-RNA levels followed by isovitixin **(25),** quercetin-3-*O*-[α-L-rhamnopyranosyl-(1→2)]-[α-L-rhamnopyranosyl-(1→6)]-β-D-galactopyrano-side **(42)** and quercetin 3-*O*-(α-L-rhamnopyranosyl-(1→2)-β-D-xylopyranoside **(41)** as TNF-a inhibitors in LPS-stimulated BV2 cells. On the other hand, quercetrin-3-O-α-L-rhamno-pyranoside **(45),** que-rcetin 3-O-(2″-O-α-L-rhamnopyranosyl-6″-trans-p-coumaroyl)-β-D-gluco-pyranoside **(46)** showed the strong antioxidant activity among the tested compounds compared to the trolox [27].

4. Conclusions:

In the nutshell of the review, the phytochemical works done on *Adenanthera pavonina* L. is quite insufficient particularly in the isolation of flavonoids, triterpinoids, saponins and glycosidic compounds. Therefore, extensive phytochemical studies might lead to the isolation of new compounds along with the assessment of their biological properties would be beneficial as new lead drug molecules. The isolated compounds of *A. pavonina* could be a potential template for the synthesis and development of new lead compound with enormous pharmacological significance.

5. Author Contributions:

MMS: data collection, design and drafted the manuscript; PK, AA & AR:revised and improve the manuscript; MI: Supervised the work.

6. Funding: No Fund Received

7. Conflicts of Interest:

There is no conflict of interest among the authors

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