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Review Article

HANSRAJ (*ADIANTUM CAPILLUS* VENERIS LINN.): A SYSTEMATIC REVIEW ON ITS ETHNOBOTANY, PHYTOCHEMICAL AND PHARMACOLOGICAL PROFILE

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ABSTRACT

Adiantum capillus-veneris Linn. of *Adiantaceae* family is one of most common plants that have found diverse medicinal uses in the indigenous systems of medicine. It has been used in cold, skin diseases, bronchitis, hair fall and inflammatory diseases. It is also considered as tonic and diuretic. The previous studies showed that *Adiantum capillus veneris* contained many secondary metabolites and exerted antimicrobial, anti-inflammatory, analgesic, hypoglycemic, antioxidant, antiproliferative, antidermatitis, neuroprotective, anti-cholesterolemic and many other effects. The present review will highlight the chemical constituents and the pharmacological and therapeutic effects of *Adiantum capillus veneris*. A wide range of chemical compounds including adiantone, diplopterol, kaempferol, naringin, neoxanthin, populnin, quinic acid, rhodoxanthin, rutin, shikimic acid, zeaxanthin etc. have been isolated from this plant. The plant leaves and stem of *Adiantum capillus veneris* L. were found to contain higher amount of triterpenoids and flavonoids. *Adiantum capillus-veneris* L., is nowadays gaining interest by the scientific researchers due to its folklorics and because of its therapeutic value, easy availability and degree of research work which is not done. The present review aims at reviewing the research works undertaken till date, on this plant in order to provide sufficient baseline information for future works and for commercial exploitation. The opening of a wide venue for further research and translation into clinical settings is also envisaged.

KEYWORDS: *Adiantum capillus veneris* Linn, *Adiantaceae*, Ethnobotany, Pharmacological profile.

INTRODUCTION

Pteridophytes make an important contribution to earth's plant diversity and form a significant dominant component of many plant communities especially in the tropical and temperate regions.[1] *Adiantum,* Maidenhair ferns, is a genus of about 200 species of ferns in the family *Pteridaceae*, though some researchers place it in its own family, *Adiantaceae*, distributed extensively over the world from cool temperate zones to hot tropical regions.[2] Ethnomedicinally, the genus is important and popularly known as "Hansraj" in Ayurvedic System of Medicine.[3] The genus name comes from the Greek, meaning "not wetting", referring to the frond's ability to shed water without becoming wet. *Adiantum capillus veneris* L. is a delicate, drooping, ornamental pale-green fern of wet, calcareous, rocky sites with short (15–30 cm) fronds, distinctive in appearance, with dark, often black stripes and rachises, and bright green, often delicately-cut leaf tissue.[4] *Adiantum capillus veneris* is one of the most common species with potential importance for medicinal and nutritive purpose.[5] It is commonly known as 'Avenca', in English as 'Maidenhair fern', in Hindi as 'Mubarka', and its trade name is 'Hansraj'.[6] In India *Adiantum capillus veneris* L. occurs mainly in the Western Himalayas ascending to an elevation of 2400 m and extending to Manipur.[7]

Vernacular names [6]

Arabic: Shairuljin, Shiruljin

Catalan: Capillera, Falsia

Dutch: Venushaar, Vrouhenhaar

English: Maidenhair fern, maria's fern, our lady's hair-;

French: Adiante, adianthe, capillaire, capillaire commun, capillaire d'italie, capillaire de montpellier, capillaire vrai, cheveux de venus

German: Frauenhaar, Venushaar

Greek: Adianton

Gujrati: Hanspadi

Hindi: Hansraj, Mubarka, Pursha

Italian: Adianto, capelvenere, capillaire, capilvenere

Kashmir: Dumtuli

Kumaon: Mubarka; la reunion: capillaire

Malta: Maiden hair, Capelvenere, Tursin il bir

Persian: Sirsiapeshane

Portugese: Avenca, cabellos de venus, capillaria, herva capillar

Roumanian: Chica voinicului, perul fetei, perul sfantei marri, vergura inveltia

Russian: Adiant, krasnvi jenskiy volos

Salt range: Parasigavarsha

Spanish: Capilera, capilera de mompeller, culantrillo de pozo

Suto: Pata lewana, pata mawa

Trans indus: Bisfaif, kirwatzei

Turkish: Baldi rikara

Table 1: Worldwide Geographical Distribution of Different Species of *Adiantum* [6]

Name of the Species	Common Name	Natural Distribution
Adiantum aethiopicum Linn.	Large Maidenhair	North Kanara, Nilgiris and Pulneys at the higher elevations, Ceylon. – Australia, New Zealand, America, Africa, East African islands.
Adiantum caudatum Linn.	*Mayurshikha*	Throughout India, Ceylon and the Malay peninsula in the plains and lower slopes of the hills- Southern china, Tropical Africa, Malay islands, Java, Mauritius, Cape verde islands.
Adiantum flabellulatum Linn.	Chinese: T'ieh Hsien Ts'ao	Assam, Nepal, Khasia, Sylhet, Ceylon: ouvah district, Malay peninsula- malay islands, Southern China, Japan.
Adiantum incisum	*Mayurshikha*	Dhaka, Chuadanga, Kushtia, Rajshahi in shade.
Adiantum lunulatum Burm.	*Hansapadi*	Throughout Northern India in moist places, Southern India very general on the West side in the plains and lower slopes of the hills, Ceylon, Burma.
Adiantum pedatum Linn.	Canadian Maiden hair fern	North west Himalayas from Garhwal to Sikkim, 6,000-9,000 ft.- Japan, North America.
Adiantum phillippense	*Hamsapadi*	North, West Indian Plains and Marshy areas.
Adiantum venustum Don.	*Mubarak*	North eastern Himalayas, 3,000-10,000 ft., Afghanistan

Habitat, Propagation and Biological Needs

The plant requires a restricted habitat - a very humid, continuously warm (year-round) microclimate on a porous, highly calcareous substrate. Overall, when hot water sources are abundant, it reproduces quickly and abundantly. The fronds wilt quickly at first frost, although fern is reported to survive occasional winter temperatures as low as –2°C. It can withstand winter temperatures to 28°F (–2°C) occasionally, but dies when temperatures decline below 0°F (–18°C). This reproduces from spores as well as vegetatively. Vegetative growth has been reported to potentially occur rapidly in the species, covering areas of approximately 2 m^2 in less than 15 years.[8]

Botanical Description

It is a delicate graceful fern, small rhizomatous, erect and perrenial herb upto 30 cm tall with long polished black stripes.[7,9,10] Fronds are simple, bipinnate, with short terminal pinna, lowest pinna side slightly branched segments 1.3-2.5 cm broad, base cuneate, outer edge rounded, deeply lobed from the circumference in the direction of centre and lobes again bluntly crenated, lowest petioles 6 mm long, texture pellucid herbaceous, thin, dark brown shiny, rachis and both surfaces naked. Leaf on upper surface bears sporangia, 6- 12 inches high, erect or drooping, alternately and doubly pinnate, stalks slender, purplish black, smooth and polished, alternate ones quite capillary. Leaflets wedge or fan-shaped, entire at the base, the upper or outer margin variously jagged and lobed, when barren sharply serrated, when fertile with each segment terminated by a roundish, flat, brown, thin indusium.[6,9,11,12] Rhizome densely scaly, creeping blackish, tufted and covered with persistant leaf bases and scales.[9,12] Stipes are blackish, 10-23 cm long, polished, suberect, rather slender and naked.[6,7] Sori conspicuous with a membranous covering occuring on the extremities of the lobes on the lower surface, elliptic or linear, arranged in rounded sinuses one to each lobe.[6,7,11,13] Pinnules are 1-1.6cm x 1- 1.2cm, green papery, laminar, surface smooth. Pinnae are dissected in the upper margin, blunt and convex. Lower margin is smooth and more or less concave. Shape of pinnae is more or less triangular. Distal margin of fertile pinnae extended and inwardly turned forming distinct soral flaps, sporangia large and attached to the margin of pinnules. Venation of pinnules is open dichotomous and they are dichotomously branched two to three times, leaves hypostomatic, stomata are present on the lower side of the epidermis and more or less parallel to the vein. Epidermal cells of both the surfaces are slightly wavy and sinuous. Upper epidermal cells are longer than broader but irregular in shape. The amplitude of sinuosity of upper epidermal cells is 17.5µm and wavelength of sinuosity is 103µm. Lower epidermal cells are irregular in shape and sinuous walled. The amplitude of sinuosity is 11µm and wavelength of sinuosity is 91µm. Stomata are confined only on lower side of the leaf. So the pinnules are hypostomatic. Trichomes are absent in pinnae. Stomata are surrounded by 3 to 5 neighbouring cells and cells are longer than broad. [14]

Traditional Uses

Adiantum capillus veneris L. is one of such plants in folk medicine that has been used for the management of various diseased conditions. The traditional uses recorded for this herb are numerous and mainly medicinal. In South Africa, tribals inhale the smoke of dried leaves to check headache, and cold.[15] In the Punjab, the leaves along with pepper, are administered as a febrifuge, and in South India, when prepared with honey, they are used in catarrhal affections. At colomas (Mexico), this plant is used as a tea to relieve colic, but at Colothan it is taken as a tea for amenorrhea. The herb is mucilaginous, pectoral, expectorant and is used as a popular cough medicine throughout most parts of Europe. It has also been used as emmenagogue. In France, large quantities are employed in the preparation of "Sirop de Capillaire". It may be used in all coughs, throat affections and bronchial disorders. The sutos smoke the leaf for head and chest colds.[6] Expressed juice with pepper is a favourite remedy in all kinds of fever.[16] The dried whole plant is used as an antipyretic and diuretic. The fern is cultivated as an ornamental plant in Japan and Europe because of its beautiful evergreen frond. [17]

Table 2: Worldwide Ethnomedical Uses [18-27]

Amazonia	For blood cleansing, coughs, excessive mucous, menstrual problems, respiratory problems, urinary disorders, urinary insufficiency and to increase perspiration.
Brazil	For asthma, bronchitis, childbirth, cough, digestion, excessive mucous, flu, hair loss, kidney problems, laryngitis, menstrual disorders, respiratory problems, rheumatism, throat (sore) urinary insufficiency and to stimulate the appetite.
Egypt	For asthma, chest colds, cough, edema, flu, hepatitis, snakebite, spider bite, splenitis, urinary insufficiency and to increase perspiration.
England	For asthma, cough, hair loss, jaundice, kidney stones, menstrual disorders, pleurisy, shortness of breath, swellings, urinary insufficiency, yellow jaundice.
Europe	For alcoholism, bronchitis, bronchial diseases, cough, dandruff, detoxification, diabetes, excessive mucous, flu, hair loss, menstrual problems and to sooth mucous membranes.
India	For boils, bronchial diseases, colds, diabetes, eczema, fever, menstrual problems, skin diseases, wounds
Iraq	For bronchitis, colds, cough, excessive mucous, flu, menstrual disorders, respiratory difficulty, reducing secretions, urinary insufficiency and to increase perspiration.
Mexico	For birth control, bladder problems, blood cleansing, constipation, hair loss, kidney stones, liver function, menstrual disorders, respiratory distress.
Peru	For asthma, colds, cough, congestion, excessive mucous, flu, gallstones, hair loss, heartburn, hydrophobia, liver problems, menstrual disorders, respiratory problems, sore throat, stomach problems, urinary insufficiency and to increase perspiration.
U.S.	For chills, coughs, excessive mucous, fever, flu, lung problems, menstrual disorders, menstrual pain, respiratory ailments, sclerosis (spleen), sores, urinary insufficiency and to sooth membranes and increase perspiration.

Contraindications and Drug Interactions

Avenca has a long history of use in herbal medicine systems to stimulate the uterus and promote menstruation; it is contraindicated in pregnancy. The plant has shown to have an anti-implantation effect in animal studies and may prevent conception. Couples seeking fertility treatment or pregnancy should not take avenca. Due to its effect on fertility and menstruation, avenca may have estrogen-like effects and should probably be avoided by women with estrogen-positive cancers. Avenca may potentiate insulin and antidiabetic drugs. [18-27]

Miscellaneous uses

The dried fronds of the plants are used to make a tea and also used as a garnish on sweet dishes. Syrup is made from the plant - it makes a refreshing summer drink.[5]

Phytochemistry

Chemical studies have shown the presence of various classes of compounds, the main ones being triterpenoids, flavonoids, phenyl propanoids, steroids, sulphate esters of hydroxycinnamic acid–sugars, alicyclic acids, lipids and long-chain compounds. [28-47] Eighty-five triterpenoids were isolated from the genus *Adiantum.* Their structures were elucidated by spectroscopic analyses. Triterpenoids and flavonoids are the dominant constituents within the genus *Adiantum.*[2] The high triterpenoid content makes the whole plant of *Adiantum capillus veneris* L. as a potential commercial source of traditional medicine.

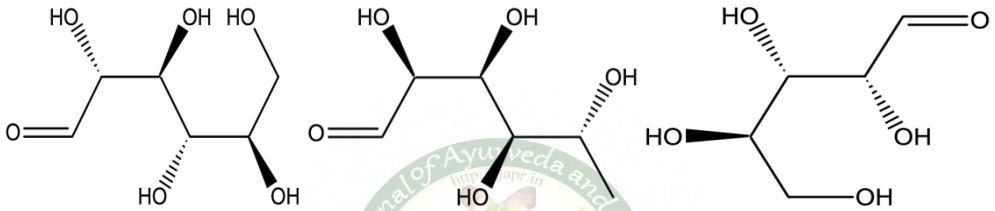
Table 3: Major Phytoconstituents isolated from *Adiantum capillus veneris* L.

Compound	Chemical type	Plant part	Plant origin
Adiantone	Triterpene	Frond	France [7,9,34]
Hydroxy adiantone	Triterpene	Frond	Italy [7,9,48]
Iso adiantone	Triterpene	Entire plant	India [21]
Isoadiantol-B	Triterpene	-	- [2]
Adian-*5-ene*	Triterpene	Frond	Japan [55]
Adian-*5*(*10*)-*en-3α-ol*	Triterpene	Frond	Japan [17]
Adian-*5-en-3α -ol*	Triterpene	Frond	Japan [17]
Adiantoxide	Triterpene	Plant	- [9]
Adipedatol	Triterpene	-	- [36]
Astragalin	Flavonoid	Frond	Japan [49]
Caffeic acid *1*-galactose-*6*-sulfate	Phenyl propanoid	Frond	Italy [31]
Caffeic acid *1*-glucose-*3*-sulfate	Phenylpropanoid	Frond	Italy [31]
1-Caffeyl glucose	Polyphenol	-	- [7]
1-Coumarylglucose	-	-	- [31]
1-Coumaryl galactose	-	-	- [31]
Campesterol	Phytosterol	-	- [9]
Carbohydrate(soluble)	Carbohydrate	Shoot	Taiwan [43]
α- Carotene	Carotenoid	Leaf	France [50]

β- Carotene	Carotenoid	Leaf	France [50]
Hydroxy cinnamic acid	Phenylpropanoid	Leaf	- [31]
Coumaric acid, para *1*-glucose-*2*-sulfate	Phenylpropanoid	Frond	Italy [31]
Coumaric acid, para *1*-glucose-*6*-sulfate	Triterpene	Frond	Italy [31]
Davallene(fern-*9(11)-ene*	Triterpene	-	- [36]
Daphnoretin	Coumarin dimmer	-	- [2]
Diplopterol	Triterpene	Frond	Egypt [45]
Diacylglyceryl-*o-4*(*N,N,N*-trimethyl) homoserine	Lipid	Frond	- [51]
17,29-epoxyhopane	Triterpene	Frond	Japan [17]
3α- epoxyfilicane	-	-	- [7,9]
4α-Epoxyfilicane	-	-	- [7,9]
Fern-*9(11)-en-12-β-ol*	Triterpene	-	Japan [37]
Fern-*9(11)-en-12-one*	Triterpene	-	- [17]
Fern-*9(11)-en-3α -ol*	Triterpene	-	- [17]
7- Fernene	Triterpene	Leaf	- [17]
Fern-*7-en-3α -ol*	Triterpene	-	- [17]
Fern-*9(11)-en-28-ol*	Triterpene	-	- [17]
Fern-*9(11)-en-12β -ol*	Triterpene	Frond	China Egypt [37]
Fernadiene, *7,9-(11)*	Triterpene	Leaf	- [17]
Filic-*3-ene*	Triterpene	Frond	Japan [17]
3α,4α-epoxyfilicane	Triterpene	Frond	Italy [35]
Galactose	Carbohydrate	-	- [2]
Hop-*22(29)*-ene	Triterpene	Frond	Japan [2]
Hopan-*28,22*-olide	Triterpene	Frond	Japan [2]
4α -hydroxyfilican-*3*-one	Triterpene	Frond	China, Egypt [37]
Hydroxyhopane	Triterpene	Frond	Japan [17]
Isoglaucanone	Triterpene	Frond	Japan [17]
Isoquercetrum	Flavonoid	Frond	Japan [7,10,13]
Kaempferol	Flavonoid	Leaf	France [10]
Kaempferol-*3-o-β -d*-glucuronide	Flavonoid	Frond	Japan [52,53]
Kaempferol-*3-o*-galactoside sulfate	Flavonoid	Frond	Italy [32]
Kaempferol-*3-o*-rutinoside sulfate	Flavonoid	Frond	Italy [32]
Kaempferol-*3*-rutinoside	Flavonoid	Frond	- [53]
Kaempferol-*3*-sulfate	Flavonoid	Frond	Italy [28]
Kaempferol-*3,7*-diglucoside	Flavonoid	Plant	- [9]
Ketohakonanol	Triterpene	-	- [2]
Lup-*20-(29)-en-28-ol*	Triterpene	-	- [2]
24-norlupan-3-one	Triterpene	-	- [2]
Lutein epoxide	Carotenoid	Leaf Leaf	France Netherlands [50]
Luteolol	-	-	- [7,9]
Mutatoxanthin	Carotenoid	Leaf	France [50]
Naringin	Flavonoid	Frond	- [53]
Neoxanthin	Carotenoid	Leaf	France [50]
Neohop-*12*-ene	Triterpene	Frond	Japan [2]
Nicotiflorin	Flavonoid	Frond	Italy Japan [32,52]
Olean-*18*-en-*3*-one	Oleanane	-	Japan [37]
Olean-*12*-en-*3*-one	Oleanane	-	Japan [37]
Populnin	Flavonoid	Frond	- [53]
Procyanidin	Flavonoid	Frond	- [53]
Prodelphinidin	Flavonoid	Frond	- [53]
Pteron-*14*-en-*7α* -ol	Triterpenoid	-	- [17]
Quercetin-*3*-o-(*6* -malonyl)-*d*-galactoside	Flavonoid	Frond	Italy Italy [29]
Quercetin-*3-o-β -d*-glucuronide	Flavonoid	Frond	- [53]
Isoquercitrin	Flavonoid	Frond	Japan

		Frond	Italy [32,53]
Querciturone	Flavonoid	Frond	Japan [53]
Quinic acid	Alicylic	Frond	Japan [54]
Rhamnose	Carbohydrate	-	- [2]
Rhodoxanthin	Carotenoid	Leaf Leaf	France Netherlands [50]
Rutin	Flavonoid	Frond	Japan Italy [32,53]
Shikimic acid	Alicylic	Frond	Japan [54]
β- sitosterol	Phytosterol	Frond	Japan [9]
Stigmasterol	Phytosterol	Frond	Japan [9]
Tetrahymanol	Triterpene	-	- [2]
Trisnorhopane	Triterpene	Frond	Japan [17]
Urs-*20-en-16*-ol	Triterpene	-	- [2]
Violaxanthin	Carotenoid	Leaf Leaf	France Netherlands [50]
Xylose	Carbohydrate	-	- [2]
Zeaxanthin	Carotenoid	Leaf	France Netherlands [50]

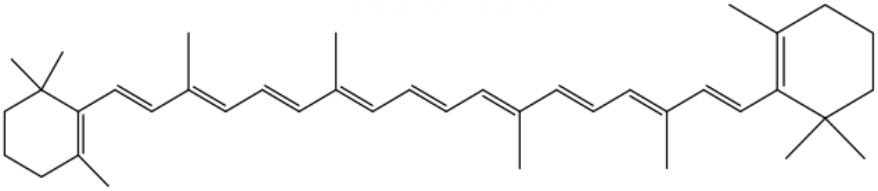
Carbohydrates



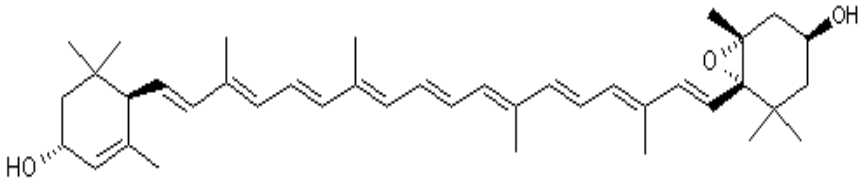
Galactose Rhamnose Xylose

Carotenoids

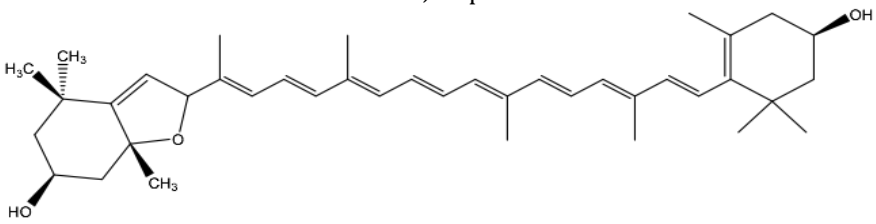
α- Carotene



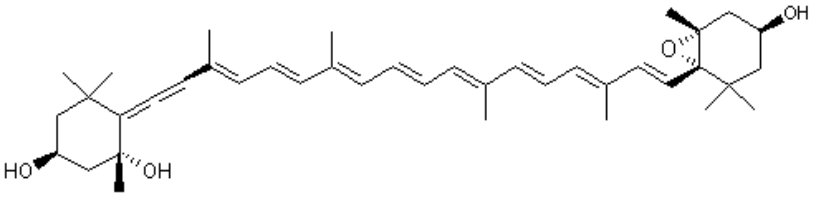
β –Carotene



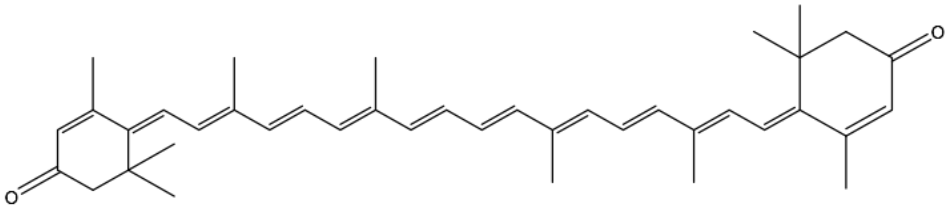
Lutein *5, 6* epoxide



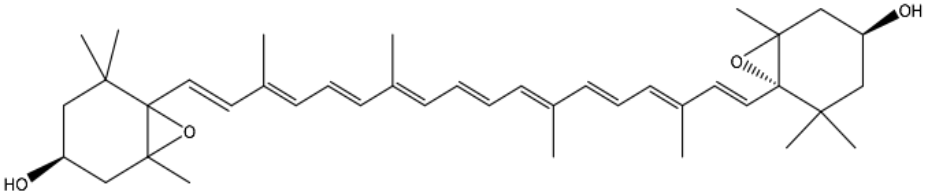
Mutatoxanthin



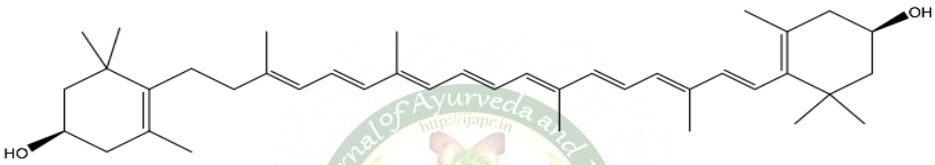
Neoxanthin



Rhodoxanthin

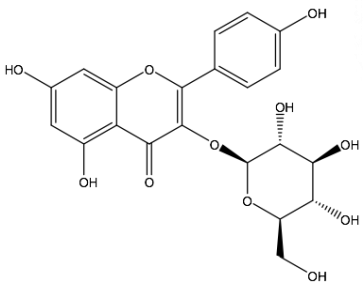


Violaxanthin

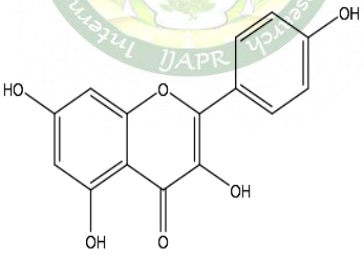


Zeaxanthin

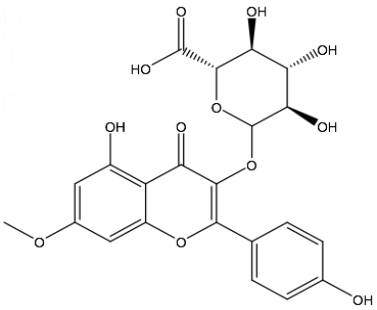
Flavonoids



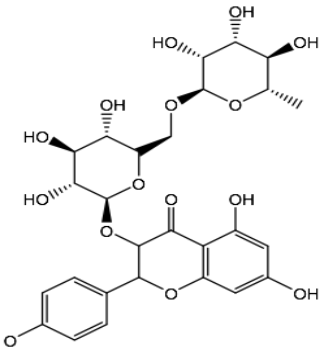
Astragalin



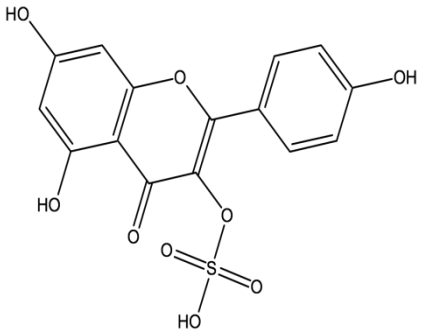
Kaempferol



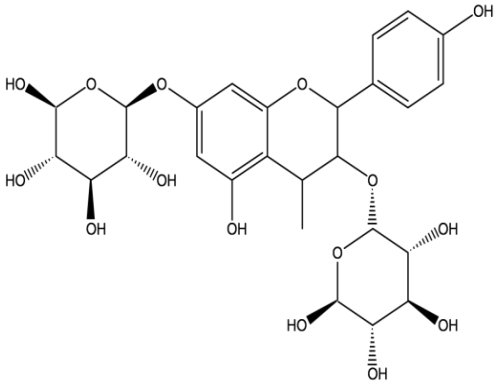
Kaempferol -*3*-beta-o-glucuronide



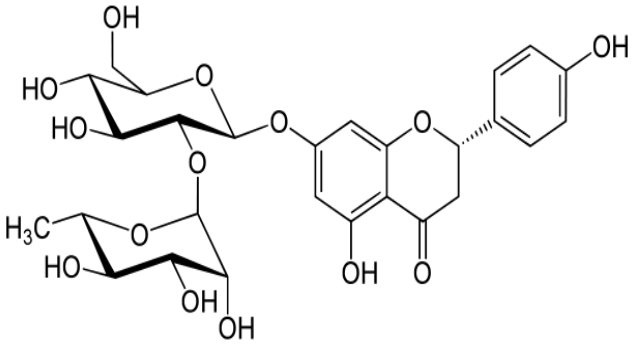
Kaempferol-*3*-o-rutinoside



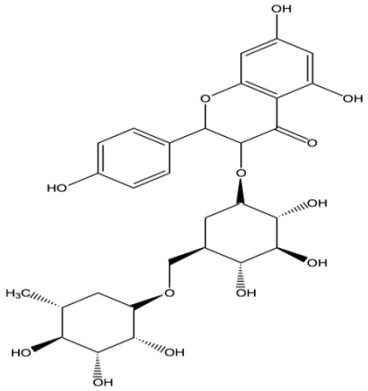
Kaempferol *3*-sulfate



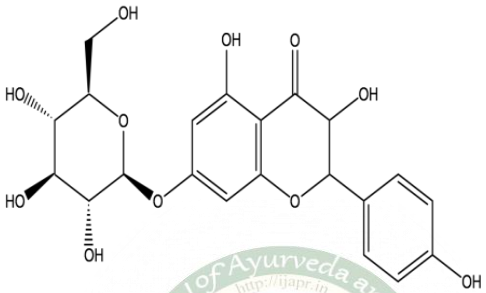
Kaempferol-*3*, *7*-diglucoside



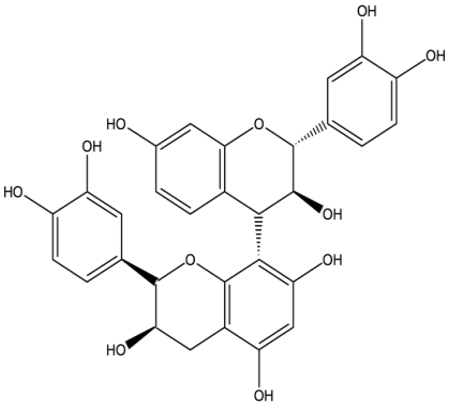
Naringin



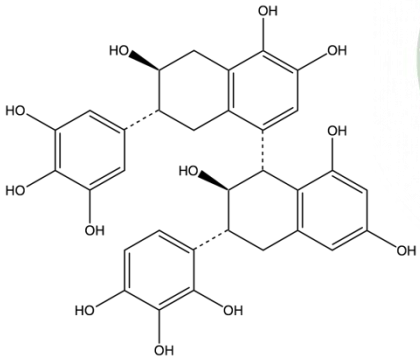
Nicotiflorin



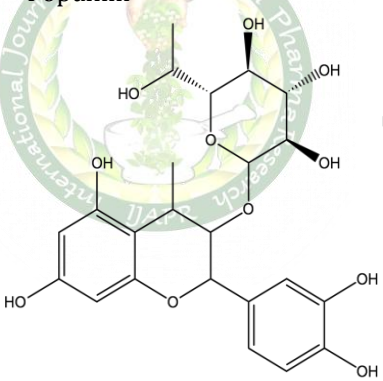
Populnin



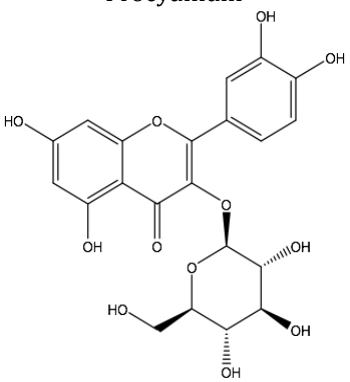
Procyanidin



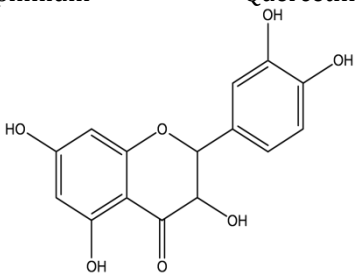
Prodelphinidin



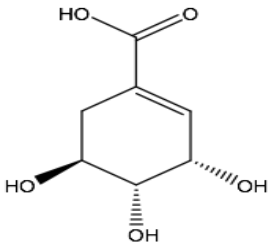
Quercetin- *3*- o – glucuronide



Isoquercitrin

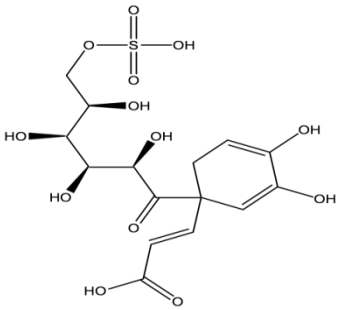


Quercetin

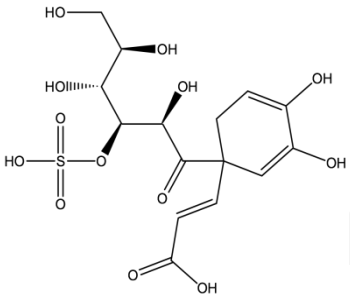


Rutin

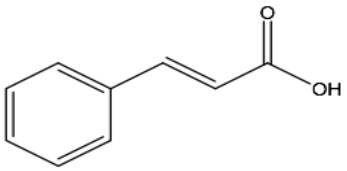
Phenylpropanoid



Caffeic acid – *1* - galactose-*6*-sulfate

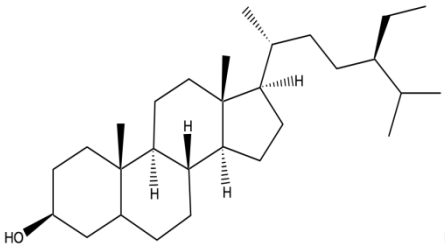


Caffeic acid *1* glucose *3* sulfate

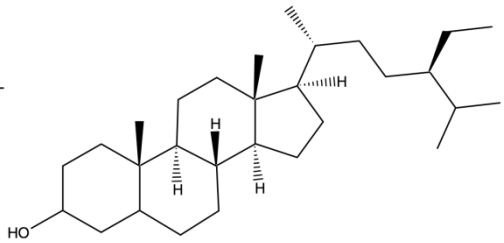


Hydroxy cinnamic acid

Phytosterol

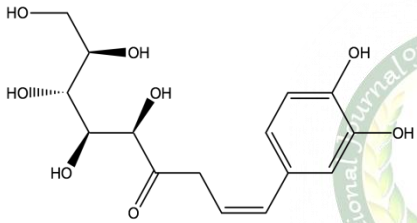


β - sitosterol

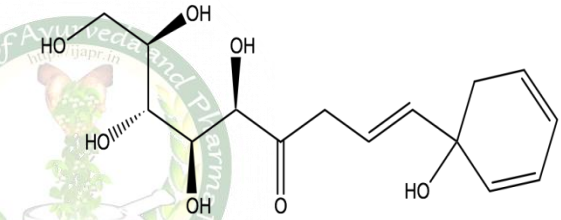


Stigmasterol

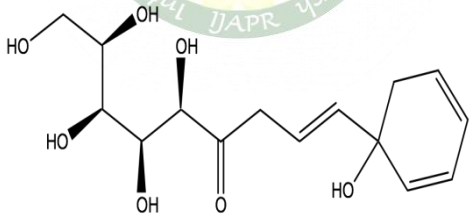
Polyphenols



1-caffeyl glucose

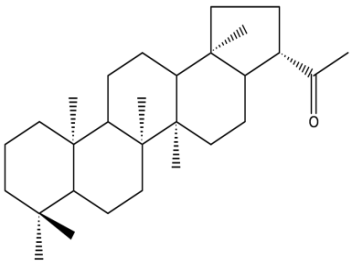


1-coumaryl glucose

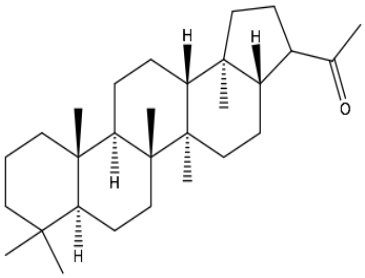


1-coumaryl galactose

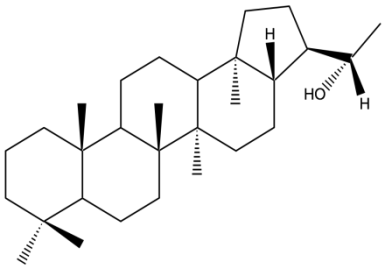
Triterpenoids



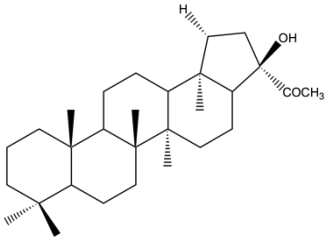
Adiantone



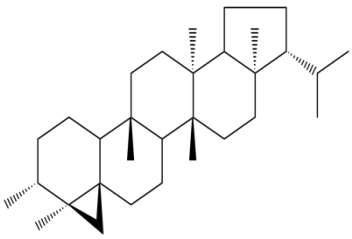
Iso adiantone



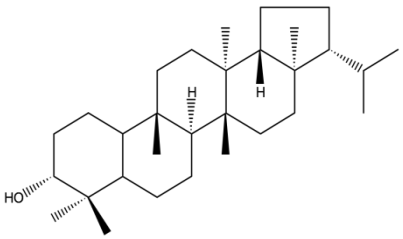
Iso adiantol-B



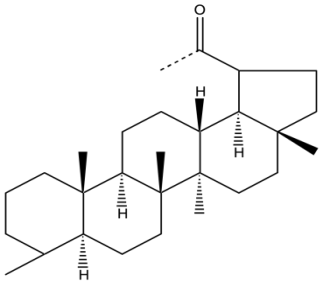
Hydroxy adiantone



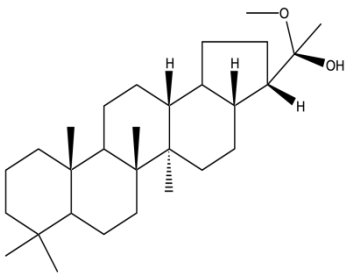
Adiantoxide



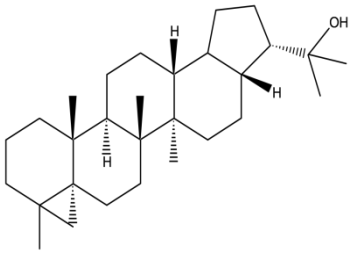
Adian-*5(10)-en-3α*-ol



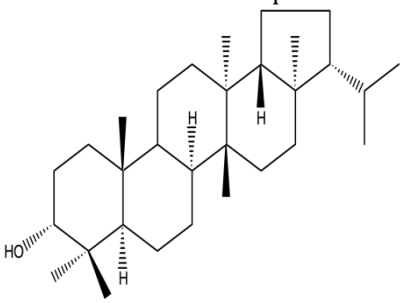
Adiantulupanone



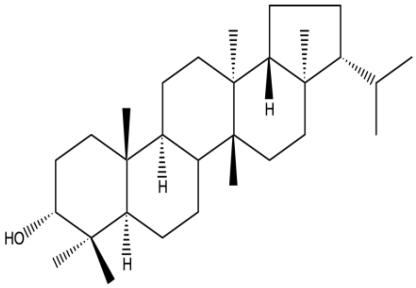
Adipedatol



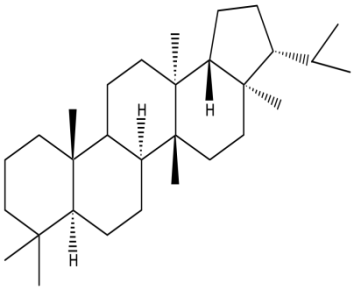
Diplopterol



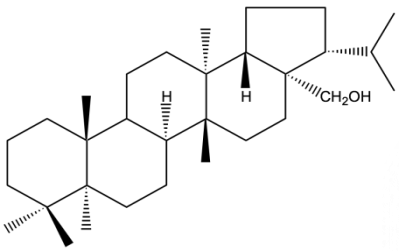
Fern-*9(11)-en-3α*-ol



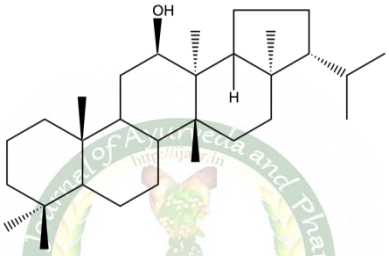
Fern-*7-en-3α*-ol



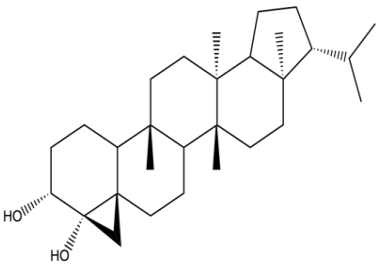
Fern-*9(11)*-ene



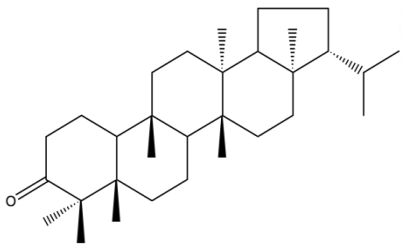
Fern-*9(11)-en-28*-ol



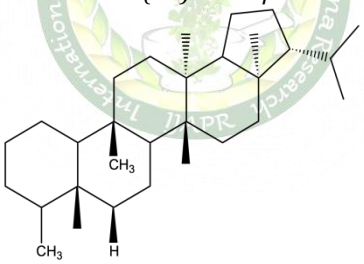
Fern-*9(11)-en-12β*-ol



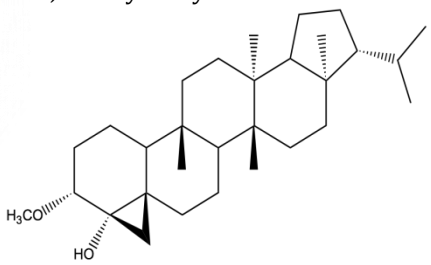
3, 4-DihydroxyFilicane



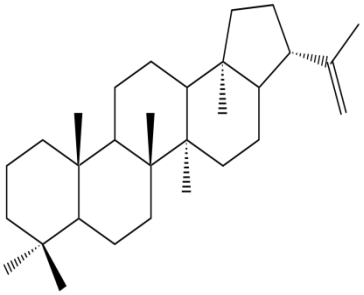
4α-hydroxy Filican-*3*-one



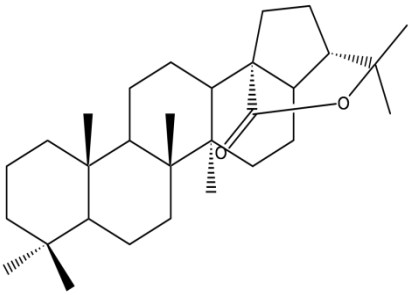
Filicene



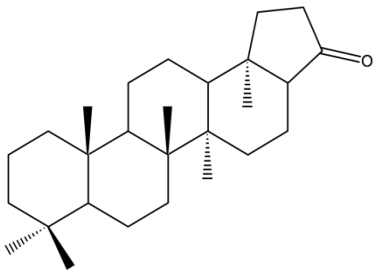
3-methoxy-*4* hydroxy filicane



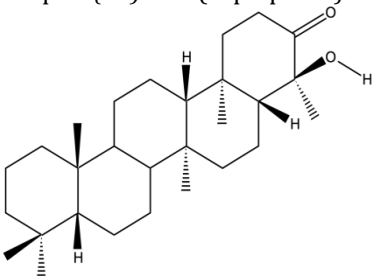
Hop-*22(29)*-ene (Diploptene)



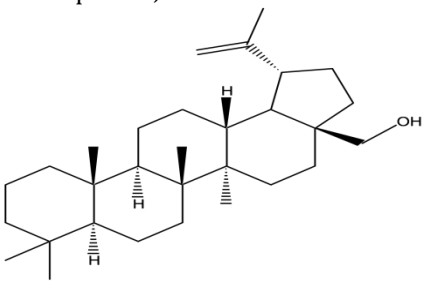
Hopan-*28, 22*-olide



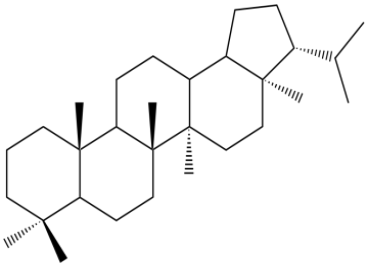
Isoglaucanone



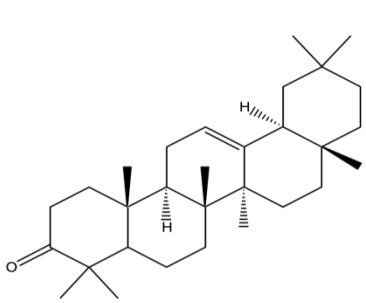
Ketohakonanol

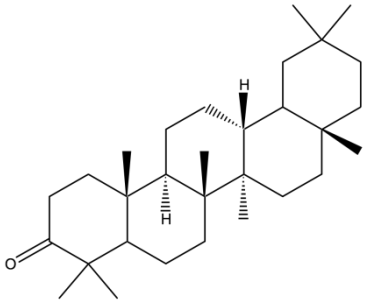


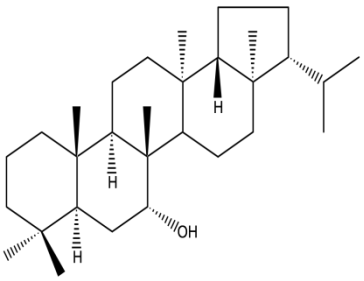
Lup-*20-(29)*-en-*28*-ol

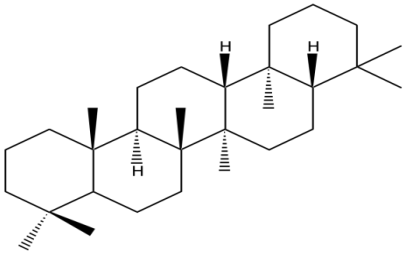


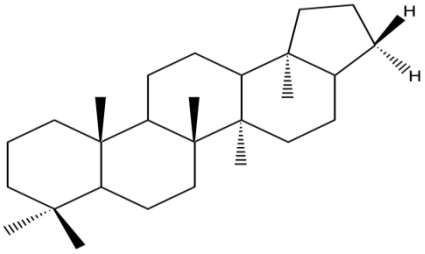
Neohop-*12*-ene


Olean-*12*-en- *3*- one


Olean-*18*-en- *3*- one


Pteron-*14*-en-*7α*-ol


Tetrahymanol


Trisnorhopane

GC-MS analysis of *Adiantum capillus-veneris* revealed the existence of α-D-Glucopyranoside, d- Mannose, 5,7-Dodecadiyn -1,12-diol, 3-Trifluoroacetoxypentadecane, Imidazole-4-carboxylic acid,2-fluoro-1-methoxymethyl-,ethyl ester, D-Carvone, Pterin-6- carboxylic acid, Pyrrolizin-1,7-dione-6- carboxylic acid, methyl (ester), D-Glucose,6-O-α-D-galactopyranosyl, Estragole, Phenol,2-methyl-5-(1-methylethyl), 3- Allyl-6-methoxyphenol, Ppropiolic acid, 3-(1-hydroxy-2-isopropyl-5-methylcyclohexyl), 7-epi-trans-sesquisabinene hydrate, Tetraacetyl-d-xylonic nitrile, y-Sitosterol, Ergosta-5,22-dien-3-ol, acetate, (3ß,22E), Curan-17-oic acid,2,16- didehydro-20-hydroxy-19-oxo,methyl ester, 9,10-Secocholesta -5,7,10(19)-triene-1,3-diol,25-[(trimethylsilyl)oxy], Cis- Vaccenic acid, L-Ascorbic acid, 6-octadecanoate, L-Ascorbic acid, 6-octadecanoate, Deoxyspergualin, Tributyl acetylcitrate, 10,13-Dioxatricyclo[7.3.1.0(4,9)]tridecan-5-ol-2-carboxylic acid, 18,19-Secoyohimban-19-oic acid, 16,17,20,21-tetradehydro-16, 9-Octadecenamide,(Z), Olean-12-ene-3,15,16,21,22,28,-hexol,(3ß,15α,16α,21ß,22α), (22S)-21-Acetoxy-6α,11ß-dihydroxy-16α,17αpropylmethylenedioxy, Ethyl iso-allocholate, Olean-12-ene- 3,15,16,21,22,28-hexol,(3ß,15α,16α,21ß,22α) and Olean -13(18)-ene.[56]

Biological Activities and Clinical Research

Table 4: Biological Activities for Compounds of Avenca (*Adiantum capillus veneris*)

Compound tested	Activity tested for	Test model / dosage	Inference
Astragalin	Antidermatitis activity [55]	Oral/ Mice/ 1.5mg/kg	Reduced the severity of pre-existing dermatitis and prevented the development of atopic dermatitis.
	Antidermatitis activity [57]	Oral/ Mice	Reduced the development of atopic dermatitis, scratching behavior and serum IgE elevation. Histology revealed reduced infiltration of inflammatory cells, degranulated mast cells, thickening of epidermis.
	Histamine Inhibition [55]	Cell culture	Inhibited histamine release by basophils
	Histamine Inhibition [58]	Cell culture	Inhibited the release of histamine by the human basophilic cell line KU812
	Antiproliferative activity [58]	Cell culture	Inhibited human mesangial cell proliferation and matrix over-synthesis possibly through decreasing β-1- integrin gene over-expression. These effects may prevent the progression of chronic renal disease.
Naringin	Anticholesterolemic activity[59]	Chick	Reduced total cholesterol, LDL, VLDL and triglycerols
	Anticholesterolemic activity[60]	Oral/ Rat/ 0.1%	Lowered plasma cholesterol and triglyceride concentrations as well as HMG-CoA reductase activity.
	DNA Protecting Effect [61]	Cell culture/ 2mg/kg	Protected mouse bone marrow cells

			against gammaradiation induced DNA damage and reduced cell proliferation.
	Hepatoprotective activity [62]	Oral/ Rabbit/ 500mg/kg	-
	Antioxidant activity [63]	Rabbit / 0.5 g/kg	Increased hepatic superoxide dismutase and catalase activity. Decreased hepatic mitochondrial hydrogen peroxide. Increased plasma vitamin E concentrations.
	Antiplatelet-activating factor activity [64]	In vitro	Inhibited the function of platelet-activating factor
Rutin	Anticholesterolemic activity [59]	Chick	Reduced total cholesterol, LDL, VLDL and triglycerols
	Gastroprotective activity [65]	Rat	Protected against reflux oesophagitis by inhibiting gastric acid secretion, oxidative stress, inflammatory cytokine production and intracellular calcium mobilization in PMNs.
	Hepatoprotective activity [66]	Oral/ mice/ 20 mg/kg	Pretreatment of mice with rutin before paracetamol overdose reduced the death rate from 100% to 40%. Pretreatment prevented the paracetamol rise in liver enzymes. Pretreatment prevented CCl4 rise in liver enzymes and prevented the CCl4-induced prolongation in pentobarbital sleeping time
	Intracellular Calcium Modulation [67]	Cell culture/ 68.3 mumol/L,136mumol/L, 274 mumol/L, 45 mumol/L	Inhibited the increase of intra platelet free calcium
	Antiplatelet-activating factor activity [68]	Cell culture/ 9.55 x 10(-9) mol/L	Inhibited platelet-activating factor and platelet aggregation
	Serotonin Release Inhibition[67]	Cell culture / IC50=0.73mmol/L IC50=1.13 mmol/L	5-HT release from platelets
Shikimic acid	Neuroprotective activity [69]	Ip Rat / 50 mg/kg	Reduced focal cerebral ischemic injury induced by middle cerebral artery thrombosis
Zeaxanthin	Photoreceptor protective effect [70]	Oral Quail/ 35 mg/kg	Protected photoreceptors from light-induced death

Table 5: Biological Activities for Extracts of Avenca (*Adiantum capillus-veneris*)

Type extract	**Activity tested for**	**Part/origin**	**Model / Dosage**	**Inference**
Aqueous	Antibacterial activity [71]	Entire Plant/ Thailand	20.0 mg, 20.0 mg, 20.0 mg, 20.0 mg, 20.0 mg	*Bacillus subtilis, Escherichia coli, Salmonella typhosa, Shigella dysenteriae, Staphylococcus aureus*
	Benzopyrene-protein Binding Inhibition [72]	Aerial parts/ Iraq	Rat Microsomes	Benzopyrene binding to rat liver microsomal protein measured
	Anti hyperglycemic activity [21]	Aerial parts/ Europe	Oral Mouse male / 25.0 mg/kg	Glucose-induced hyperglycemia
	Hypoglycemic activity [73]	Entire plant/ India	Oral Rabbit / 10.0 mg/kg	-
	Antiyeast activity [71]	Entire plant/ Thailand	Agar Plate / 20.0 mg	*Candida albican*
Ethanol (95%)	Antiviral activity [74]	Rhizome/ France	Cell culture / Variable	Vesicular stomatitis virus
	Anti-inflammatory and Anti-nociceptive [75]	Frond/ India	Ethanol extract (200 mg/kg po and 300 mg/kg po), Ethylacetate fraction (300 mg/kg po)	Significant anti-inflammatory and analgesic effect/ ethyl acetate fraction exhibited better inhibition (67.27%)

	Anti-inflammatory [76]	Dried fronds/ Egypt	Total alcoholic extract, hexane fraction (400 mg/ kg, each)	Significant anti-inflammatory activity
	Antibacterial activity [71]	Entire plant/ Thailand	Agar plate/100.0 mg, 100.0 mg, 100.0 mg, 100.0 mg, 100.0 mg	*Bacillus subtilis, Escherichia coli, Salmonella typhosa, Shigella dysenteriae, Staphylococcus aureus*
	Antiyeast activity [71]	Entire plant/ Thailand	Agar plate / 100.0 mg	*Candida albicans*
Ethanol (80%)	Antibacterial activity [77]	Leaf/ Iran	Agar plate/ 100.0 mcg/ml	Several gram + organisms Several gram - organisms
	Antibacterial activity [71]	Stem/ Iran	Agar plate/ 100.0 mcg/ml	Several gram +ve organisms Several gram -ve organisms
	Benzopyrene-protein Binding Inhibition [72]	Aerial parts/ Iraq	Not stated/ 8.0 mcg/ml	Aryl-hydrocarbon hydroxylase activity measured
	Anti Hyperglycemic[22]	Aerial parts/ Europe	Oral/ Mouse male/ 25.0gm/kg	Glucose-induced Hyperglycemia
Methanol	Antibacterial activity[19]	Aerial parts/ Iraq	Agar plate / 0.5 mg/ml,1.0mg/ml, 1.0 mg/ml, 2.0 mg/ml, 2.0 mg/ml	*Bacillus subtilis, Escherichia coli, Staphylococcus aureus, Proteus vulgaris, Pseudomonas aeruginosa*
	Moulting activity (insect) [78] Moulting activity (insect) [79]	Entire plant/ Japan Entire plant/ Taiwan	Injection/ 10.0 microliters 10.0 mg	*Sarcophaga peregrine* *Sarcophaga peregrine*
	Antiyeast activity [19]	Aerial parts/ Iraq	Agar plate/ 2.0 mg/ml Agar plate/ 20.0 mg/ml	*Candida albicans* *Candida pseudotropicalis*

Pharmacological Activities

The extract of the *Adiantum* species as well as pure compounds isolated from them, have been demonstrated to possess multiple pharmacological activities including analgesic, antinociceptive, anti-implantation and antimicrobial activities.

Anti-implantation activity[2]

Petroleum ether extracts of *A. capillus* and isoadiantone were reported to be active as inhibitors of postcoital implantation in rats.

Antimicrobial activity[2]

The methanol extract of *A. capillus-veneris, A. peruvianum, A. venustum* and *A. caudatum* have been tested for their antimicrobial activity against five Gram positive, six Gram negative (including multiresistant *Staphylococcus aureus*) bacterial and eight fungal strains using standard microdilution assay. Maximum activity was exhibited by *A. venustum* followed by *A. capillus-veneris*, *A. peruvianum* and *A. caudatum*. The extract of *A. capillus-veneris* had very low MIC value (0.48 µg/mL) against *Escherichia coli*, whereas *A. venustum* extract activity against *Aspergillus terreus* showed an MIC of 0.97 µg/mL. T otal phenolic constituents of *A. venustum*, *A. capillus-veneris*, *A. peruvianum* and *A. caudatum* were 0.81, 0.83, 0.71 and 0.52 % w/w (gallic acid equivalent), respectively, implying that the observed activity may be related to the content of phenolics. Pradeep *et al* reported that aqueous and alcohol extracts of *A. capillus-veneris* and *A. incisum* were effective against *A. tumefaciens*; aqueous and alcohol extracts of *A. capillus-veneris* and *A. lunulatum* against *E. coli* and *S. typhi;* alcohol extract of *A. incisum* against *Salmonella arizonae*; aqueous and alcohol extracts of *A. capillus- veneris* and *A. incisum*, and alcohol extract *of A. lunulatum* against *S. aureus.* The methanol extract of *A. trapiziforme* inhibited the growth of *Bacillus megaterium* and *Staphylococcus aureus* B-43-5. Older plants showed more pronounced activity than activity than vegetative ones. Using disk susceptibility tests, the antibacterial activity of adiantone, 22,29ξ-Epoxy-30-norhopane-13β-ol, fern-9(11)-en-28-ol, fern-9(11)-en-25-oic acid, fern-9(11)-en-6α-ol, fern-9(11)- ene, filicenol B and 6-oxofern-9(11)-ene were assayed against Gram negative bacteria *Escherichia coli* (ATCC 25922), *Pseudomonas aeruginosa* (ATCC 25619), *Salmonella typhi* (ATCC 23564) and Gram positive bacteria *Bacillus sphaericus* (ATCC 14577), *Bacillus subtilis* (ATCC 6051), and *Staphylococcus aureus* (ATCC 9144). Compounds adiantone,fern-9(11)-en-25-oic acid,fern-9(11)- enewere highly active against *S. typhi* and moderately active against *P. aeruginosa*, while compound 22,29ξ-Epoxy-30-norhopane-13β-ol showed moderate activity against *S. typhi*. The other compounds did not show significant activity against the tested bacterial strains. Interestingly, Gram negative bacteria, except *E. coli*, were highly susceptible to compounds adiantone,fern-9(11)-en-25-oic acid, fern-9(11)- eneand comparable with the positive control, kanamycin. Alcohol extracts of the rhizome of *A. capillus- veneris* effectively inhibited the proliferation and metabolism activity of rifampicin-resistant pulmonary tuberculosis cells.

Antiviral activity[2]

Using vesicular stomatitis virus in monkey cell cultures as test organism, the extracts of *A. capillus-veneris* was found to exhibit antiviral activity.

Agglutinating activity[2]

Lectin from the leaves of *A. flabellulatum* had a characteristic of glycoproteins, exihibiting agglutinating activity on rabbit erythrocytes, as well as human

erythrocytes of A, B, or O groups, but had no activity on turtle erythrocytes. It agglutinated cells of unicellular alga (*Chlorella pyrenoidosa*), natural or heat-treated cells of yeast (*Saccharomyces cerbvisiae*) and heat-treated cells of *Bacillus subtilis*. In addition, it was specific for not only some marine algae, as well as bacterial, yeast and tumor cells but also for two species of plant harmful germ and bacteria, *Helminthosporium turcicum* and *Pseudomonas solanacoarum*.

Insect-molting hormone activity[2]

Leaf material from New Zealand ferns was examined for insect molting hormone activity by using the housefly larvae for bioassay. Activity was found in most species including the genera *Adiantum*.

Antithyroidal activity[80]

In PTU induced hypothyroidism, the ethanol extract of the fern *A. capillus-veneris* increased the level of T3, T4 significantly and reversed the increase in thyroid weight (goitre) induced by thiouracil. This evidence suggests its thyroid hormone enhancing effect and anti-goitrogenic effect. In addition, the level of malondialdehyde (MDA) was lowered and the levels of antioxidant enzymes were increased when treated with *A. capillus-veneris* in hypothyroid animals. With the outlined results, *A. capillus- veneris* could be used for hypo-thyroidism regulation.

Patented formulations of *adiantum capillus veneris* linn.

Table 6: Patented formulations

Patent no.	Publication date	Title	Composition of Formulation	Activity/ Use
JP2004182712A	02-07-2004	Active oxygen-eliminating agent and skin external preparation composition [81]	*Myrica nagi* Hook. F. non Thunb, *Saraca asoca* De Wilde, *Homonia riparia* Lour, *Hemidesmus indicus* (L.) R. Br., *Adiantum capillus-veneris* L. and *Mucuna pruriens* (L.)DC	Active oxygen-eliminating agent excellent in the prevention and improvement of aging of a skin in view of its safety, stability and effectiveness
JP 2006257059A	28-09-2006	Androgen receptor binding inhibitor, agent for hair and skin care preparation for dermal use formulated with the same [82]	One or two or more kinds of solvent extracts selected from a group comprising *Adiantum capillus-veneris* L., *Mucuna pruriens* (L.) DC., *Murraya koenigii* (L.)Spreng, *Ocimum sanctum* L., *Onosma bracteatum*, *Rosmarinus officinalis*, *Leonotis nepetifolia* (L.)R.Br.	Hair restoring/pilatory effect and improvement of skin such as dandruff, pimple and dermatitis
CN 1628769	22-06-2005	Blood fat lowering and meridians dredging medicine and its preparation [83]	Raw materials (by weight ratio) *Cassia* seed 8-15, *Curcuma longa* 140-160, *Alisol* 190-210, *Notoginseng* 40-50, *Adiantum capillus-veneris* 190-210	Blood fat lowering and meridians dredging medicine
JP2004182710	02-07-2004	Collagen production accelerating agent [84]	*Adiantum capillus-veneris* L., *Ocimum sanctum* L. and *Saraca asoca* De Wilde	Skin external agent and a beauty food blended with the effective collagen production-accelerating agent
CA 2588874A1 EP 1758542 A1 US20070110705 A1	16-06-2005 07-03-2007 17-05-2007	Composition comprising *Urginea maritima* or *Drimia maritima*, *Laurus nobilis*, *Adiantum capillus-veneris*, and *Persea americana* and its use against hair greasiness, hair loss and for promoting hair growth [84-87]	*Urginea maritime* or *Drimia maritime, Laurus nobilis, Adiantum capillus- veneris, Persea americana*	Hair washing and, clearance product and hair fortifier used against greasiness, sebum, hair loss and result in hair growth
EP 1172109A1 EP 1172109A9 EP1172109B1 US7211567B1	16-01-2002 03-04-2002 01-03-2006 01-05-2007	Compositions for preventing and treating type I allergy [87-91]	-	External preparation for skin for preventing or treating type I allergy.

JP 2006-257056 A	28-09-2006	Estrogenic agent and composition for skin care preparation for external use[92]	One or two or more solvent extracts of a group comprising *Adiantum capillus-veneris* L, *Calophyllum inophyllum* L., *Cyperrus rotundus* L., *Evolvulue alsinoides* L., *Rhododendron arboreum*, *Saraca indica*, *Vanda roxburghii, Jacaranda decurrens cham., Rosmarinus officinalis, Bauhinia forficate* L, *Bixa orellana* L., *Echinodorus grandiforus* (Chem.et Schl.) *Micheli, Maytenus ilicifolia Mart. Ex Reissek*, and *Erythroxylum catuaba*	External use for amelioration of the skin with reduced skin function accompanied by aging.
CN 101152264	02-04-2008	Medicament for treating prostate disease and urinary tract infection and method for preparing the same [93]	Raw materials of 30 percent to 70 percent weight of *Adiantum capillus veneris* and 30 percent to 70 percent weight of *Purslane speedwell* herb, or the raw materials are combined with *Hedyotis*, *Tassel* flower and herb of common sage.	Prostate hyperplasia, prostate hypertrophy, clears heat and promoting diuresis, dissipating blood stasis for detume-scence and inducing diuresis for treating strangury.
CN 1742886	08-03-2006	Medicated liquor of cortex Zanthoxyli podocarpi[94]	*Makoupiziyao*, *Adiantum capillus-veneris*, *Cayratia japonica, Desmodium elegans, Clerodendron serratum* and white liquor	Rheumatic arthritis, rheumatic arthralgia and myalgia and traumatic injuries.
CN101804090 A	18-08-2010	Tablet used for treating prostate diseases as well as preparation method and application thereof [95]	*Adiantum capillus-veneris*, *Spina gleditsiae, Vaxxaria* seed	Prostate diseases

CONCLUSION

It is evident from the available literature that *A. capillus veneris* L, possesses adequate therapeutic potential and could be explored further for commercial purposes. This study attempts to highlighted the therapeutic potential of *A. capillus veneris* L. and their constituents in the prevention or therapy of disease. From this study we can conclude that the results reviewed in the study are aimed at attracting the attention of researchers seeking new drugs from *A. capillus veneris* L. and its chemical compounds. The isolated compounds can hopefully be considered in future for more clinical evaluations and possible applications and as adjuvant to current medications. We should maintain our efforts in considering and valorizing our natural patrimony as well as conducting more research in *A. capillus veneris* L. and its pharmacological aspects. Nevertheless, despite the important and varied pharmacological studies available, clinical tests are necessary to confirm the use of this species in medical practice.

Further research work needs to be initiated to provide scientific base and look for the possible role of these plants extract to treat neuro-degenerative diseases and also the possible role of acting as anti-HIV, anti-diabetic, anti-inflammatory, antioxidant, anti-stress, anti-convulsant agent in human models. Nutritional quality evaluation of this plant has not yet been reported. If the plant extracts are found to be rich in essential minerals, then food biofortification can also be tried.

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