



PHYTOCHEMISTRY AND ETHNOPHARMACOLOGICAL STUDY OF *ADIANTUM CAPILLUS-VENERIS* L. (MAIDENHAIR FERN)

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Abstract

The present study provide detail description of *Adiantum capillus-veneris*, is an important endangered fern species with several medicinal properties. The plant has shown antibacterial activity against pathogens such as *Bacillus subtilis*, *Pseudomonas aeruginosa*, *Streptococcus faecalis*, *Salmonella typhi* and *Staphylococcus aureus*. The medicinal properties including antibacterial, antifungal, antioxidant, anti-inflammatory, analgesic, hypoglycemic, lithotriptic etc. could be concluded from the plant during investigation. The other aspects of the plant such as antiobesity effect, goitrogenic, antithyroidal, wound healing property and urinary tract effect also substantiated and evaluated. The anti-inflammatory and analgesic performance of 300mg/kg (oral) ethanolic extract of *A. capillus-veneris* in mice were estimated and validated through assessment with apposite standards. It is an herbal medicinal plant; some of its traditional uses are oral powders of Maidenhair fern were extensively administrated for gastrointestinal disorders such as jaundice, diarrhoea and abdominal cramps. Maidenhair fern is a potent hair tonic that treats alopecia and helps hair growth and useful for dandruffs also. The information of bioactive phenolic compounds in *Adiantum* leaves can prove to be subject of interest for medical researcher especially in the field of homeopathy and ayurvedic medicine.

Key words: Ethnopharmacology, *Adiantum capillus-veneris*, Maidenhair fern, Herbal medicine, Bioactive-phenolic compounds.

Introduction

Adiantum capillus-veneris L. is important endangered fern species with several medicinal properties and taxonomically belong to family Pteridaceae and Subfamily Vittarioideae. There are over 200 species reported by the genus (Prado *et al.*, 2007). In India, 23 species are reported so far with maximum 15 species occurring in South India and Western Ghats (Mithraja *et al.*, 2012). It is commonly known as hansraj, maidenhair fern and venus hair fern. It is Geographically distributed in India [including Kashmir, Himachal Pradesh, Sikkim, Darjeeling, Nagaland, Meghalaya, South India, Uttarakhand (Dehradun, Pauri-Garhwal, Uttarkashi, Chamoli, Nanital, Almora)]; Asia (Afganistan, China, Japan, Malaya, Myanmar, Nepal, Srilanka), Africa. The *A. capillus-veneris* species possess different pharmacological properties. Many alkaloids and bioactive

components responsible for their therapeutic properties have been isolated and identified (Brahmachari *et al.*, 2003). The *in vitro* antilithiasic activity of hydro-alcoholic take out of *Adiantum* was worked out and showed momentous drop in the number of crystals in experimental models (Vijayalakshmi and Kumar, 2013). The present study provides a comprehensive description of the species including phytochemistry, morphological, medicinal, traditional and bioactive components. The study is first of its kind for *A. capillus-veneris* L. from Dehradun, India and will provide a firm platform for pharmaceutical industries.

Material and Methods

The present study was based on repeated sites visits, conducted from May to November, 2016 in Dehradun, Uttarakhand, India to collect the study plant material *A. capillus-veneris* commonly called maidenhair fern (Fig. 1). The entire plant, fronds and leaves were utilized for

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the ethnopharmacological studies (Singh *et al.*, 2018; 2019a; 2020). The identification, nomenclature with synonyms was based on Brummitt and Powell, (1992) and Smith *et al.*, (2006).

Results and Discussion

Morphology

The rhizome was wide-creeping, slender, thin, densely clothed with scales; scales brown, linear-lanceolate, apex acuminate, base wide, non-peltate, margin smooth. The stipe was 10-16cm blackish, thin, scaly at base, slender and shiny above. The lamina was bi or tri-pinnate at base, spreading, 10-20cm×5-12cm, apical part simply pinnate, deltoid ovate, herbaceous, glabrous, glaucous, light-greenish to dark-green. The rachis was zig-zag, thin, blackish like stipe; and pinnae 5-6 pairs, stalked, alternate, ascending. The pinnules were 3-5 pairs, shortly stalked, fan-shaped, dimidiate, cuneate, ovato-cuneate, apex curved, margin irregular, deeply 2-3 lobed and finely dentate. The lobes were obtuse and dentated in sterile part; however, texture herbaceous, glabrous and thin. The venation was conspicuous, free; veins distinct, dichotomously branched, veinlets one to each tooth, flabellately forked 2-4 times into 5-8 veinlets in each lobe and each sterile pinnule receiving single veinlets. The sori were larger, roundish, placed in roundish sinuses, one to each lobe indusiate. The indusium were reniform-lobate, marginal on lobes; indusium false (pseudo-indusium) formed by the reflexed margin of lamina; sporangia small and globose. The spores were dark-brown, tetrahedral, trilete, 40-45µm × 50-55µm, non-perinate and exine smooth.

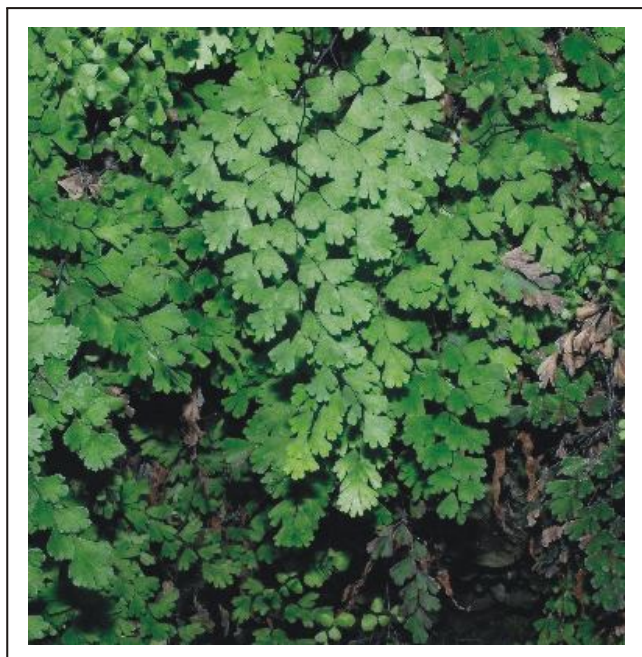


Fig. 1: *Adiantum capillus-veneris* plant in its native habitat.

Anatomy

The thin hand sections of the stem were done for microscopy studies. The sections were cleared in solution chloral-hydrate solution, stained by phloroglucinol and hydrochloric acid, followed by glycerine mounting for histological taxonomic identification of different parts. The transverse section of stem reflected presence of thick walled heavily cutinized epidermis and hypodermis, followed by ground tissue composed of parenchymatous cells with air spaces. The ground tissue comprised meristemes also. The cortex was parenchymatous with starch granules and stele consisted single-layered endodermis followed by pericycle. The stele was represented by number of scattered meristeme; triarch xylem and surrounded by phloem.

Crude powder

The dried crude powdery material of leaves, stems and entire plants was separately treated with phloroglucinol, hydrochloric acid and glycerine to study various characteristics (Table 1).

Bio-chemical assay

The quality and purity of the drug material was based on the fluorescence characteristics of crude powdered material of different parts of the selected model *A. capillus-veneris*. The fluorescence is an observable fact reflected by a variety of chemical constituents available in plant material. The gas chromatography (GC) and mass spectroscopy (MS) analysis of compounds was carried out in methanolic extract (Table 2). The Kumar *et al.*, (2010) reported the activities of some plant constituents having temperament of flavonoids, palmitic acid (hexadecanoic acid, ethyl ester and nhexadecanoic acid), unsaturated fatty acid and linolenic (docosatetraenoic acid and octadecatrienoic acid) terpenoids, saponins, tannins, alkaloids and glycosides. The Bharathy *et al.*, (2012) analysed that the phytol was a diterpene with antimicrobial activities, appreciably in opposition to lots of bacterial strains.

Traditional medicine

The *A. capillus-veneris* has applied in the treatment

Table 1: Chemical features of crude powder from different parts of *Adiantum capillus-veneris*.

Compound	Stem	Leaf	Entire plant
Foreign organic matter	1.2%	0.8%	2%
Total ash	8.5%	6.5%	9.5%
Acid-insoluble ash	3%	4.5%	4.5%
Water-soluble extractive	2%	5.5%	8%
Alcohol-soluble extractive	7.2%	6.4%	5.6%
Moisture content	1.5%	0.5%	3.5%
Crude fiber content	8%	2%	14%

Table 2: The 15 major bioactive phytochemical compounds in *Adiantum capillus-veneris*.

S. No.	Phytochemical name	Structure	Medicinal importance
1	Dodecanoic acid, ethyl ester	C ₁₄ H ₂₈ O ₂	Hypercholesterolemic activity, antioxidant activity.
2	Nonadecane	C ₁₉ H ₄₀	Antioxidant activity, anti-inflammatory
3	Tetradecanoic acid	C ₁₄ H ₂₈ O ₂	Emploid in cosmetics and contemporary medicinal manufacturing for efficient inclusion through skin as desired.
4	3,7,11,15-Tetramethyl-2-hexadecen-1-ol	C ₂₀ H ₄₀ O	Used as flavouring agent, modulate transcription in cells, antibacterial, antioxidant and anti-proliferative
5	Acetic acid, 3,7,11,15-tetramethyl-hexadecyl ester	C ₂₂ H ₄₄ O ₂	Anti-bacterial and anti-proliferative activity
8	Docosane	C ₂₂ H ₄₆	Antibacterial activity, antimicrobial
9	1,2-Benzenedicarboxylic acid, butyloctyl ester, phthalic acid, butyl octyl ester	C ₂₀ H ₃₀ O ₄	Antimicrobial, antifungal and antioxidant, immunomodulatory activity
10	n-Hexadecanoic acid	C ₁₆ H ₃₂ O ₂	Antioxidant, hypocholesterolemic, nematocide, anti-androgenic, flavor, hemolytic
11	Hexadecanoic acid, ethyl ester	C ₁₈ H ₃₄ O ₂	Antifungal, anti-tumour, antibacterial
12	9-Octadecenoic acid.	C ₁₈ H ₃₄ O ₂	Antimicrobial, antioxidant, hepatoprotective, hypocholesterolemic as well as cancer preventive activity
13	Octadecanoic acid, ethyl ester	C ₂₀ H ₄₀ O ₂	Anti-inflammatory activity
14	Di-n-octyl phthalate	C ₂₄ H ₃₈ O ₄	Antimicrobial, antivenom activity
15	Tetracontane	C ₄₀ H ₈₂	Anti-inflammatory, anti-cancer and anti-HIV, antibacterial activity

of cold, live and spleen's tumours, cutaneous diseases, bronchitis and inflammatory problems. It was well thought-out as tonic and diuretic drug also. The oral application of fronds decoction was reported to be useful for cleansing respiratory system and also applicable in the cure of dyspnoea, asthma, coryza and chest pain along with headaches (Shirazi *et al.*, 2011). The application of Maidenhair fern as oral powders was extensively administrated for gastrointestinal disorders such as jaundice, diarrhoea and abdominal cramps. Maidenhair fern was a known potent hair tonic that treats alopecia, helps hair growth and off the dandruffs. The concentrated leaves extract of *A. capillus-veneris* was engaged for acute bronchitis, fever. The leaves were also chewed in the management and treatment of mouth blisters. The fronds extract was used as an eye ointment in combination to honey. At second-hand it was a potent stimulant, fibrifige, expectorant, purgative and demulcent, along with anticancerous, hypoglycaemic, aphrodisiac, antibacterial, antifungal and antiviral activities.

Activities identity tests

The macroscopic and microscopic examinations, thin layer chromatography, GC-MS analysis along with biochemical assays were assessed to evaluate and validate the pharmacological and biochemical behaviour of the target parts of the *A. capillus-veneris*.

- Antimicrobial activity: The *in vitro* antibacterial activity of *A. capillus-veneris* was performed by disc

diffusion method (Guha *et al.*, 2004). The aqueous and alcoholic leaves extract of *A. capillus-veneris* were found to be effective against *Agrobacterium tumefaciens*, *Escherichia coli*, *S. arizonae*, *S. typhi* and *S. aureus* strains with maximum zone of inhibition against *S. faecalis*. A previous study by Medrar *et al.*, (2014) demonstrated that the *P. aeruginosa* was the most vulnerable. The aqueous and methanolic extracts showed comparative higher competence against *P. aeruginosa* than the drug amoxicillin. The antibacterial activity of Maidenhair fern against multidrug resistant (MDR) bacteria strains was assessed through methanol extract of the leaves and recorded highest zone of clearance/inhibition in opposition to *Providencia*, *Klebsiella pneumoniae*, *Shigella*, *Vibrio cholera*, *S. aureus*, *Proteus vulgaris* and *S. typhi*. However, the stem methanol extract was very high against *E. coli*, *K. pneumoniae* and *S. typhi*. The aqueous extract of the leaves was awfully tough against all bacteria strains but water extract of stem revealed minimum zone of inhibition against *E. coli*, *K. pneumoniae*, *S. typhi*, *Shigella*, *P. vulgaris* and *Providencia* (Medrar *et al.*, 2014). In another study, the antibacterial activities of *A. capillus-veneris* methanolic extract against *S. aureus*, *E. coli* and *Helicobacter pylori* has been proven (Shirazi *et al.*, 2011). The study of crude and phenolic extracts of gametophyte and sporophyte of the plant were analysed for antibacterial properties also. The gametophytic part of the plant showed significant antibacterial effect

corroborated to the *B. subtilis* susceptibility against both extracts after Guha *et al.*, (2004). It was observed that the ethanolic extract of Maidenhair fern aerial parts have no antimicrobial potential against three pathogen bacteria including *E. coli*, *S. aureus* and *P. aeruginosa* (Besharat *et al.*, 2009).

The methanolic extract of plant resulted notable antifungal activities against *Aspergillus niger*, *A. terreus*, *A. flavus*, *A. fumigatus*, *Candida albicans*, *Saccharomyces cerevisiae*, *Fusarium* sp., *Microsporum canis*, *Streptococcus faecalis*, *Mucor* sp., *Penicillium expansum*, *Trichoderma viride*, *T. horzianum* and *Trichophyton mentagrophytes*. The aqueous extract and extracted biophenols from gametophytes and different parts of sporophytes of *A. capillus-veneris* was assessed for antifungal activity and found to be bioactive against *A. niger* and *Rhizopus stolonifer* (Ishaq *et al.*, 2014). The comparative bioassay analysis reflected that the gametophytes were found to be more potent antifungal agent than sporophytes. Among the diverse parts of sporophytes, the immature pinnule possessed highest fungi inactive features (Ranjan *et al.*, 2014). Thus the different extracts of all used parts revealed that the Maidenhair fern possess potential for antibacterial and anti-fungal properties.

- **Anti-oxidant activity:** The antioxidant potential of leaves extract of *A. capillus-veneris* was assessed *in vitro* next to H₂O₂ induced oxidative injure in peripheral blood lymphocytes (Kumar, 2009). The pre-treatment of tissue with leaves extract for 18hrs successfully inhibited lipid peroxidation and augmented the activities of antioxidant enzymes and glutathione appreciably. The results indicated might be due to direct free radicals scavenging and in this manner modulating the antioxidant defence mechanism (Sultan *et al.*, 2012). The ultrasonic-assisted flavonoid extract of plant has been evaluated for the antioxidant capacity also. The *in vitro* assays were done through α,α -diphenyl- β -picrylhydrazyl (DPPH), scavenging ability of superoxide anion, chelating capability of ferrous ion and reducing power tests. The results showed Maidenhair fern has more potential as antioxidant than other antioxidants such as butylated hydroxytoluene (BHT), ethylenediaminetetraacetic acid (EDTA) and ascorbic acid (vitamin C). The experiment demonstrated significant decline in superoxide dismutase (SOD), catalase (CAT) and glutathione (GSH) levels and extraordinary boost in malondialdehyde (MDA) levels (Kumar *et al.*, 2010). In another *in vitro* examination ethanolic extract of *A. capillus-veneris* leaves has activity against hydrogen peroxide-induced oxidative damage in peripheral blood lymphocytes. It was supposed due to obstruction of lipid peroxidation and elevation of

antioxidant enzymes level including SOD, CAT, GSH and glutathione peroxidase (GPx) corroborated to Bharathy *et al.*, (2012). The antioxidant activity of plant essential oil because of carvone, carvacrol and thymol was confirmed through DPPH (Khodaie *et al.*, 2015).

- **Anti-inflammatory activity:** The significant anti-inflammatory activity by the alcoholic extort of *A. capillus-veneris* was observed against formalin based inflammation due its hexane tiny proportion after 6hrs of treatment. However, the anti-inflammatory potential of hexane fraction from alcoholic extract was continued after 30hrs against croton oil induced topical inflammation (Jain *et al.*, 2014). The ethyl acetate small part of ethanolic extract of Maidenhair fern showed significant inhibition of hind paw oedema induced by carrageenan (Chimie *et al.*, 2015). It was reported that the activity was due to inhibition of nitric oxide (NO) release and reducing in tumor necrosis factor alpha (TNF- α) level. The anti-inflammatory property of triterpenes in the plant extract also assessed (Yuan *et al.*, 2013; Janbaz *et al.*, 2015). In another study, two triterpenoids (30-normethyl fernen-22-one and 4- α -hydroxyfilican-3-on) that was isolated from fronds ethanolic extract reflected immense potential of anti-inflammatory role against carrageenan-induced hind paw edema test in rat (Haider *et al.*, 2013).

- **Analgesic and hypoglycemic activity:** The analgesic activity of ethanolic extract of *A. capillus-veneris* was assessed after tail flick method. The analgesic activity of entire extract and its fractional constituents was noteworthy with irrelevant ulceration in comparison to the typical drug during tail flick and writhing test (Chimie *et al.*, 2015). The significant hypoglycemic activity of the alcoholic extract of the plant was assessed also that initiated after 30 minutes of treatment and sustained till 4hrs (Jain *et al.*, 2014).

- **Antidiabetic activity:** The anti-diabetic effect of aqueous and methanol extracts of Maidenhair fern was determined through streptozocin-induced diabetic rat model. It was observed that there was improvement in the fasting blood sugar which exhibited that the species has very good anti-diabetic effect with low side effects. The anti-diabetic effect may be due to presence of flavonoids and tannins (Ranjan *et al.*, 2014). Another research showed that there was significant rise in rat's body weight and amylase enzyme and reduction in the blood glucose. The ability of the plant to gain weight was because of its repair capacity on hepato-renal damaged cell (Sultan *et al.*, 2012). In a report it was declared that the *Adiantum* species displayed antihyperglycemic property compared to acarbose as reference drug (Kasabri *et al.*, 2017).

- **Neuro-pharmacological activity:** The neuro-pharmacological activities of the plant's ethanolic extract was analysed by different methods which revealed significant anticonvulsant effect through exposure for long duration. The onset of action and reduction in the period of seizures in pentylenetetrazole (PTZ) induced convulsion model displayed depressant property by increasing the static time. The species did not show any remarkable skeletal muscle relaxation as well (Jain *et al.*, 2014).

- **Hypocholesterolemic, anti-obesity and antithyroidal effect:** The hypo-cholesterolemic effect of aqueous extract of *A. capillus-veneris* was analysed using high cholesterol diet (HCD) fed model in rats. The results revealed strong reduction of total cholesterol (TC), low-density lipoprotein (LDL) and very-low-density lipoprotein (VLDL) serum levels with no effects on high-density lipoprotein (HDL) level (Chimie *et al.*, 2015). In another experiment the water extract of aerial parts of the herb showed phospholipase inhibitory effect because of chlorogenic acid as the most accountable phyto-constituent (Kasabri *et al.*, 2017). It has been demonstrated that the application of plant material responsible for significant decrease in size of thyroid gland. However, the thyroid peroxidase action, antioxidant enzymes, T₄ and T₃ serum levels augmented in animals; on contrary strongly decreased thyroid stimulating hormone (TSH) serum level was noticed along the side (Vijayalakshmi and Kumar, 2013).

- **Wound healing and hair growth promoting activity:** In an *in vitro* study, the wound healing property of *A. capillus-veneris* was found. The water extract of the plant improved angiogenesis remarkable by using both capillary-like tubular formations and multiplication of endothelial cells. On the other hand aqueous and butanolic fractions showed significant protection against damage to fibroblasts treated by oxygen free radicals (Nilfroushzadeh *et al.*, 2014). A report showed that an ointment consisting Maidenhair fern, *Aloe vera*, *Henna* and *Myrrha* cured wounds in diabetics (Galehdari *et al.*, 2016). The hair growth- promoting effect of ethanolic extract of Maidenhair fern was demonstrated through testosterone-induced alopecia model. The results showed significantly increased follicular density and anagen/ telogen ratio (Noubarani *et al.*, 2014).

- **Renal treatment activity:** The efficacy of *A. capillus-veneris* water extract was assessed on urinary tract infection against systemic *Candida albicans* infection model in mice. The application of extract significant reduced the colony-forming units (CFU) of *C. albicans* responsible for urinary tract infection with

enhanced renal pathological characteristics and doubled the diuresis activity (Yuan *et al.*, 2010; Ahmed *et al.*, 2013a; Singh *et al.*, 2019b). It was noticed that the low dosage mostly raised the urinary output; on contrary the high doses remarkably reduced the urinary output. In another study, the hydro-alcoholic extract of *A. capillus-veneris* was evaluated for anti-calcium oxalate urolithiasic properties in male rats and found that there was significant decrease in number of crystals and reduction in serum level of calcium, phosphorous and blood urea (Ahmed *et al.*, 2013b). In an *in vitro* study the controlled crystallization, crystal aggregation, as well as limiting the number and sizes of crystals was observed after treatment (Haider *et al.*, 2011).

- **Analgesic and anti-nociceptive activities:** The Maidenhair fern has confirmed the analgesic effect due to ethyl acetate fractions in the ethanolic extract through tail-flick and writhing methods (Yuan *et al.*, 2013). Similar research findings had established powerful analgesic effect of Maidenhair fern through hot plate and tail immersion tests in mice earlier (Jain *et al.*, 2014). Additionally the 4- α -hydroxyfilican-3-on that was isolated from ethanolic extract of the plant showed remarkable anti-nociceptive activity in writhing test (Haider *et al.*, 2013). The anti-inflammatory and analgesic activities of ethanol extract from *A. capillus-veneris* in rats were proved *via* comparison of this extract with appropriate standards of indomethacin and ibuprofen respectively. In a report it was stated that the Maidenhair fern could damage spleen and advised that the herb should not be used in susceptible patients and pregnant women (Gruenwald *et al.*, 2008).

- **Antidiarrheal, antispasmodic and antiasthmatic activity:** In a study, the crude extract of dried leaves of *A. capillus-veneris* was assessed for antidiarrheal and antispasmodic activities. The antidiarrheal effect was proven through castor oil-induced diarrhoea in mice model. Moreover, inhibitory effect on K⁺-induced contraction was observed in isolated rabbit jejunum preparation that established the antispasmodic activity of the plant (Swaroop *et al.*, 2012). The leaves were authenticated anti-asthmatic effect of ethanolic extract through histamine aerosol-induced asthma in guinea pig and it was noteworthy in traditional use of herb as anti-asthmatic agent also (Yousaf *et al.*, 2016).

- **Detoxification and toxicity activity:** The crude extract of Maidenhair fern showed powerful protection through Bisphenol A (BPA) induced reproductive system toxicity in rats (Kanchan, 2013). In an earlier experiment the ethanol extract of the plant at 500 mg/kg doses after 14 days therapy showed remarkable nephron-protective

activity against cisplatin-induced nephropathy (Alwan *et al.*, 1989). The inhibitory effects of ethanolic and aqueous extracts of maidenhair fern on aryl hydrocarbon hydroxylase (AHH) and epoxide hydrolase (EH) enzyme activities assessed which were responsible for escalating conversion of carcinogenic compounds like poly aromatic hydrocarbons to active components (Haider *et al.*, 2011).

The toxicity study of Maidenhair fern crude ethanolic extract was carried out in rat which demonstrated behavioural reactions in experimental model at 300, 1000 and 2000mg/kg doses for variable time intervals without the cause of mortality (Swaroop *et al.*, 2012; Vijayalakshmi and Kumar, 2013; Yuan *et al.*, 2013). The acute oral toxicity of aqueous and methanolic extracts was recorded at 2000mg/kg as single dose with remarkable change in behaviour without lethality after first 30minutes, 4hrs and 24hrs (Ranjan *et al.*, 2014). The plant should not be used in pregnant women during

lactation period (Gruenwald *et al.*, 2008).

The applicability of the Maidenhair fern in homeopathy and ayurvedic medicine well established against certain health consequences including cold, tumours of internal organs, skin problems, bronchitis and inflammation (Singh *et al.*, 2008; Haider *et al.*, 2011). The extract of aerial parts of the target plant species had well-built anti-microbial, anti-urolithic performance based on earlier literatures (Singh *et al.*, 2008; Ahmed *et al.*, 2013a,b; Reinaldo *et al.*, 2015). The phytochemical analyses of *Adiantum* leaves extort publicized the existence of flavonoids, alkaloids, tannins, saponins, glycosides, steroids and terpenoids with antioxidant, anti-bacterial and anti-fungal activity (Jiang *et al.*, 2011; Ishaq *et al.*, 2014).

Bioactive phenolic compounds analyses

The phenolic compounds were identified through

comparing absorption spectra of the sample with available standard compounds or forms. The absorption spectra reported the occurrence of 4-Hydroxybenzoic acid; 3-*O*-Caffeoylquinic acid; 2-Caffeoyl tartaric acid; Kaempferol-3-feruloylsophorose-7-glucoside; p-Coumaric acid; Rosmarinic acid; Coumaric acid derivative (p-coumaric *N,N*-diphenyl amide; p-coumaric-8-hydroxy quinoline ester; p-coumaric 3-chloro-4-nitroanilide; p-coumaric naphthyl amide); 5-*O*-Caffeoylquinic acid; Quercetinhexoside derivatives; Caffeic acid hexoside; Kaempferol-3-*O*-sophorotrioside; Quercetinrhamnoside-hexoside; and Quercetin-3-galactoside in the *Adiantum* leaves extract (Fig. 2). The bioactive phenolic compounds profiling oriented literatures identified seven bioactive compounds with anti-inflammation and anti-hypoglycemic medicinal values (Ibraheim *et al.*, 2011; Yuan *et al.*, 2012).

Conclusion

There are over 200 species reported by the genus, In India, 23 species are reported so far with maximum 15 species occurring in South India and Western Ghats. *Adiantum capillus-veneris* L. is important endangered fern species with several medicinal

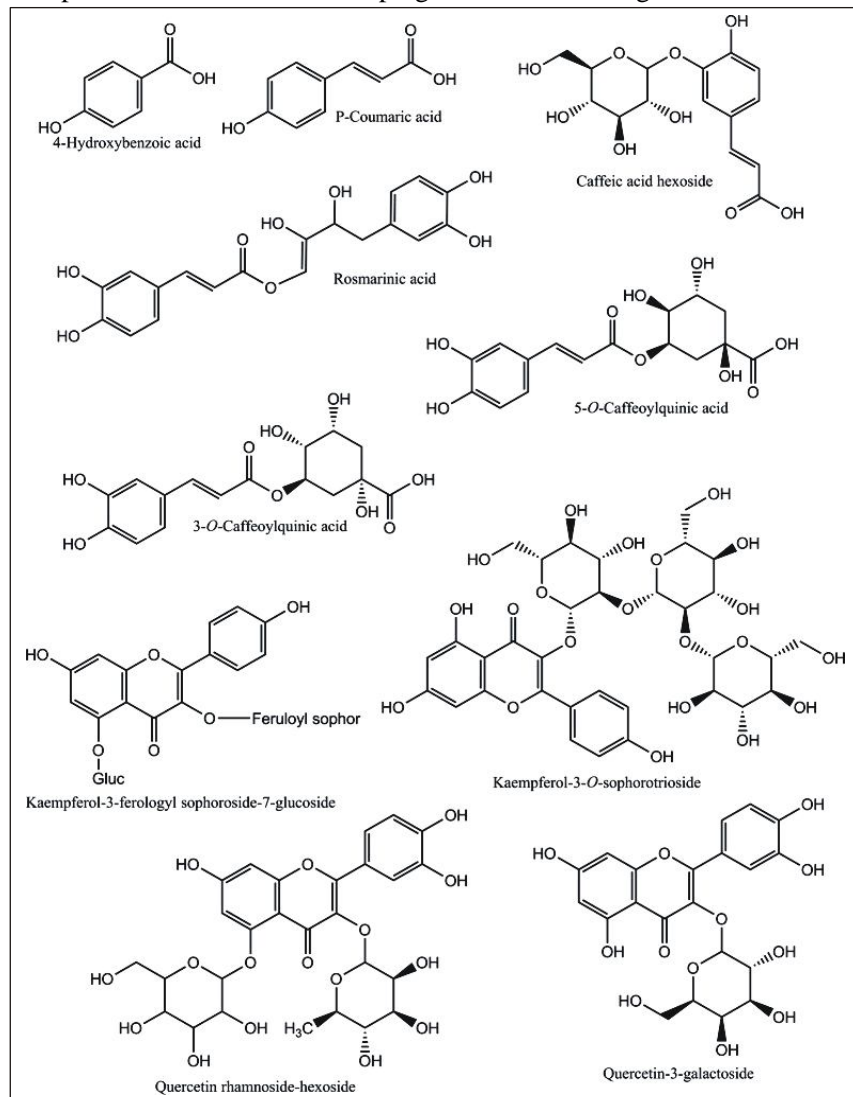


Fig. 2: The nomenclature and molecular chemical structure of bioactive phenolic compounds in *Adiantum* leaves extract. Source: Kumar *et al.*, 2014.

properties and taxonomically belong to family Pteridaceae and Subfamily Vittarioideae. It is commonly known as hantsraj, maidenhair fern and venus hair fern. The pharmacological properties including antibacterial, antifungal, antioxidant, anti-inflammatory, analgesic, hypoglycemic, lithotriptic etc. could be concluded from the plant during investigation. The present study also analyse the anatomical and phytochemical constituents of the plant. Many alkaloids and bioactive components responsible for their therapeutic properties have been isolated and identified.

Conflicts of interest

The author claims no conflicts of interest because none financial support was received from any government, non-government agency or organization to conduct this research work.

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