SERBD-International Journal of Multidisciplinary Sciences
ISSN (Online): 2581-8376
Volume 02 Issue 04, Oct- Dec, 2019

A MONOGRAPH ON MEDICINAL FERN –*Adiantum capillus-veneris* L.

Chhaya Singh[1], Neha Chauhan[2]
1. Goverment Degree College, Thalisain, Pauri Garhwal, India
2. Department of Medical Microbiology, College of Paramedical Sciences, SGRRU, Dehradun, India
Email: singh_june07@rediffmail.com; chauhanneha7777@gmail.com

ABSTRACT: ***Adiantum capillus-veneris L. is a fern used in various medicinal systems. However, scientific reporting ofand uses in drugs via pharmacopeias and clinical data still missing. The present monograph is written to emphasize its thorough knowledge about biology and medicinal values. We hope that this monograph will be able to provide complete information related to Adiantum capillus-veneris in all aspects.***

Keywords: ***Fern; Medicinal plant; Electrohomeopathy; Phytochemicals; antimicrobial; anti-inflammatory.***

INTRODUCTION

We feel pleased to bring out the present monograpgh for the students undergoing research in the field of electrohomeopathy and botany. The monograph contains detail description of the *Adiantum capillus-veneris*. *Adiantum capillus-veneris* is important endangered fern species with several medicinal properties.The monograph contains complete description of plant *Adiantum capillus-veneris* along with its common name, vernacular name, distribution nationally and internationally and its habitat. The fern has shows antibacterial activity against pathogen such as *Bacillus subtilis*, *Pseudomonas aeurogenosa*, *Streptococcus faecalis*, *Salmonella typhi* and *Staphylococcus aureus*. The monograph also emphasis on medicinal potential checked by chemical assays, major chemical constituents and its electrohomeopathy uses in a comprehensive manner. The electrohomeopathy studies reveals that the medicinal properties of Adiantum leaves, anti-inflammatory and analgesic effects **(Haider *et al.*, 2011)** are driving the attention of phytochemists to look for other chemical constituents that might be of the potential biological interest. The antiinflammatory and analgesic activities of 300 mg/kg (oral) ethanol extract from *Adiantum capillus-veneris* in rats were proved via comparison of this extract with appropriate standards. It might interest graduate students and researchers of life sciences, chemistry and medical field and indicate the scope of the area. *Adiantum capillus-venerisis* an herbal medicinal plant which is part of traditional medicine too, with broad area of research in many directions, and there exist excellent texts that give a comprehensive summary of the basic results. 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 it is useful for dandruffs.

The language of the monograph is simple, illustrated self-explanatory and structures taken from authentic sources. A monograph contains recent and excellent information that gives an overview of plant *Adiantum capillus-veneris* and its connections to other areas.

AN OVERVIEW

Adiantum capillus-veneris is an important endangered fern species with several medicinal properties.

Gujarati: Hanspadi
Hindi: Hansraj, Mubaraka, Pursha
Kannada : Hansraj
Persian : Sirsiapeshane
Tamil : Seruppadai
Kashmir : Dumtuli
Urdu : Persia – ushan

Description: Rhizome wide-creeping, slender, thin, densely clothed with scales; scales brown, linear-lanceolate, apex acuminate, base wide, non-peltate, margin smooth. Stipe10-16cm black, thin, scaly at base, slender, above shining. Lamina bi or tri-pinnate at base, spreading, 10-20 cm×5-12cm, apical part simply pinnate, deltoid ovate, herbaceous, glabrous, glaucous, light-green to dark-green; rachis zig-zag, thin, blackish like stripe; pinnae 5-6 pairs, stalked, alternate, ascending; pinnules 3-5 pairs, shortly stalked, fan-shaped, dimidiate, cuneate, ovato-cuneate, apex curved, margin irregular, deeply 2-3 lobed and finely dentate; lobes obtuse and dentated in sterile part; texture herbaceous, glabrous, thin. Venation conspicuous, free; veins distinct, dichotmosuly branched, veinlets one to each tooth, flabelluately forked 2-4 times into 5-8 veinlets in each lobe, each sterile pinnule receiving single veinlets. Sori large, roundish, placed in roundish sinuses, one to each lobe, indusiate; indusiumreniform-lobate, marginal on lobes; indusium false (pseudoindusium) formed by the reflexed margin of lamina; sporangia small, globose. Spores dark-brown, tetrahedral, trilete, 40-45µm x 50-55µm, non-perinate, exine smooth.

MICROSCOPIC CHARACTERISTICS

The thin hand sections of the stem were done for microscopy studies. The thin sections were cleared with chloral hydrate solution and stained with phloroglucinol and hydrochloric acid, then mounted in glycerin for the identification of various regions.

Transverse section of stem (Figure 1) showed the presence of thick walled heavily cutinized epidermis and hypodermis followed by the ground tissue composed of parenchymatous cells with air spaces. In the ground tissue, meristeles are present.

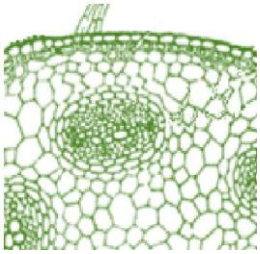


Figure 1: Transverse section of stem

Cortex parenchymatous and contains starch grains; stele consists of single layered endodermis followed by pericycle; xylem triarch, surrounded by phloem

Powdered plant material: Powder of the dried whole plant was separately treated with phloroglucinol, hydrochloric acid and glycerin to study various characteristics.

GENERAL IDENTITY TESTS

Macroscopic and microscopic examinations, thin layer chromatography, GC-MS analysis.

Purity tests

Microbiology

Clinical pathogens were selected for antibacterial activity namely, (*Bacillus subtilis, Pseudomonas aeurogenosa, Streptococcus faecalis, Salmonella typhi and Staphylococcus aureus*. Maximum zone formation was against *Streptococcus faecalis*. Methanolic extraction of plant showed notable antifungal activities against *Aspergillus niger, Aspergillus terreus, Aspergillus flavus, Aspergillus fumigatus, Candida albicans, Saccharomyces cerevisiae, Fusarium sp., Microsporum canis, Streptococcus faecalis, Mucor sp., Penicillium expansum, Trichoderma viride, Trichoderma horzianum and Trichophyton mentagrophytes*.

CHEMICALS

Table 1. Chemical composition in different parts of plant

Type of chemical	Amount in Stem	Amount in Leaves	Amount in Whole plant
Foreign organic matter	1.2%	0.8%	2.0%
Total ash	8.5%	6.5%	9.5%
Acid-insoluble ash	3.0%	4.5%	4.5%
Water-soluble extractive	2.0%	5.5%	8.0%
Alcohol-soluble extractive	7.2%	6.4%	5.6%
Moisture content	1.5%	0.5%	3.5%
Crude fibre content	8.0%	2.0%	14.0%

Chemical assays

The fluorescence character of powdered drug plays a vital role in the determination of quality and purity of the drug material. Fluorescence is the phenomenon exhibited by various chemical constituents present in the plant material. Gas chromatography and mass spectroscopy analysis of compounds was carried out in methanolic leaves extract of *Adiantum capillus-veneris*

Major chemical constituents

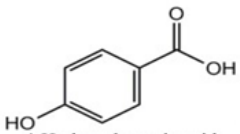
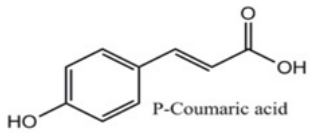
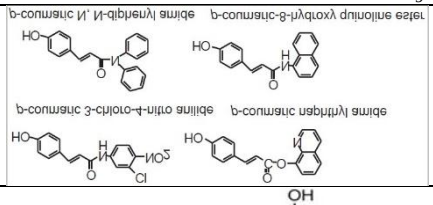
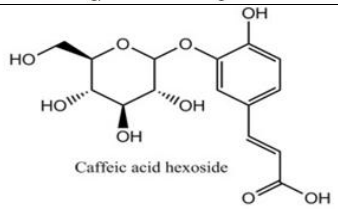
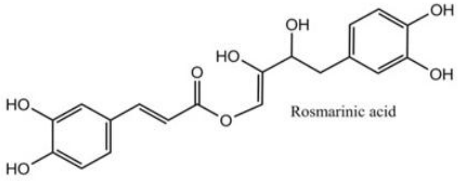
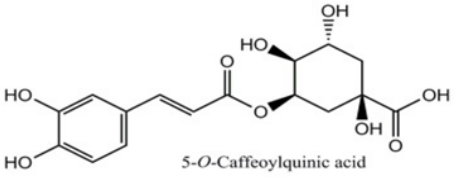
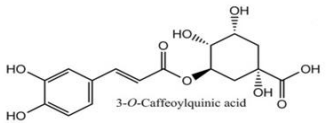
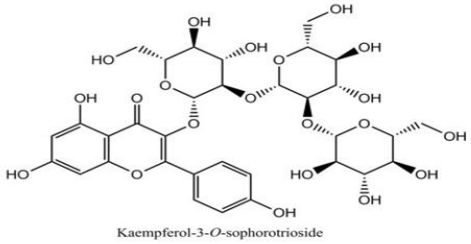
GC/MS analysis revealed the presence of 105 compounds, 6 of them could not be identified. Of these 15 bioactive and few phenolic compounds are mentioned in table 2.

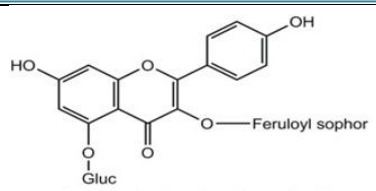
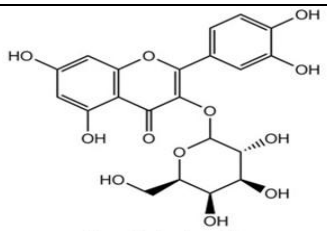
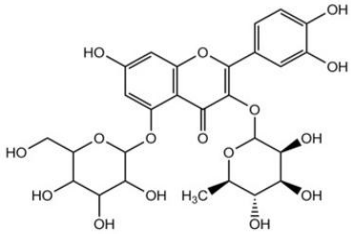
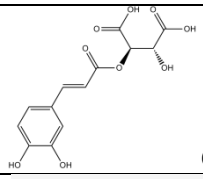
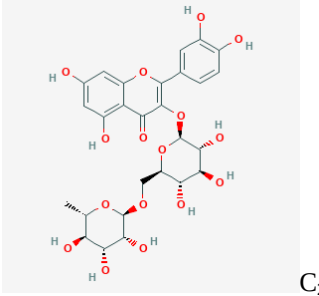
Table 2: Chemicals with proposed medicinal values present in *Adiantum*

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	$C_{14}H_{28}O_2$	It is used in cosmetic and topical medicinal preparations where good absorption through the skin is 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, butyl octyl 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, Nematicide, 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	$C_{24}H_{38}O_4$	Anti-microbial, anti- venom activity
15	Tetracontane	$C_{40}H_{82}$	Anti-inflammatory, anti-cancer andanti-HIV, anti-bacterial activity

16. Phenolic compounds structure and medicinal properties

4-Hydroxybenzoic acid	 4-Hydroxybenzoic acid $C_7H_6O_3$	antioxidant
P-coumaric acid	 P-Coumaric acid $C_9H_8O_3$	antioxidant, inhibit the signaling pathways linked to gene expression of tyrosinase and inflammatory mediators
Coumaric acid derivatives		
Caffeic acid hydroxide	 Caffeic acid hexoside $C_{15}H_{18}O_9$	Antioxidant, anti-inflammatory, anticancer, and antiviral abilities.
Rosmarinic acid	 Rosmarinic acid $C_{18}H_{16}O_8$	antioxidant and anti-inflammatory for the treatment of asthma and reactive airway diseases, allergic disorders
5-O-caffeoylquinic acid	 5-*O*-Caffeoylquinic acid $C_{16}H_{18}O_9$	hypoglycemic, hypolipidemic, anti-inflammatory, antioxidant, and other pharmacological properties including diabetes mellitus
3-O-caffeoylquinic acid	 3-*O*-Caffeoylquinic acid $C_{16}H_{18}O_9$	Antioxidant, anti hepatitis, liver protection activity and suppress carcinogenesis
Kaempferol-3-O-sophorotrioside	 Kaempferol-3-*O*-sophorotrioside $C_{33}H_{40}O_{21}$	antimicrobial, anticancer, antioxidant properties, anti-inflammatory, cardioprotective, dermal wound healing, neuroprotective, antidiabetic, anti-osteoporotic, estrogenic/antiestrogenic, anxiolytic, analgesic and antiallergic activities

Kaempferol-3- ferologyl sphoroside-7-glucoside	 Kaempferol-3-ferologyl sophoroside-7-glucoside $C_{43}H_{48}O_{24}$	antioxidant, anti-inflammatory, antimicrobial, anticancer, cardioprotective, neuroprotective, antidiabetic, anti-osteoporotic, dermal wound healing, estrogenic/antiestrogenic, anxiolytic, analgesic and antiallergic activities
Quercetin-3-galactoside	 Quercetin-3-galactoside $C_{21}H_{20}O_{12}$	Antioxidant, carcinogenesis, neurodegeneration, dermal wound healing, atherosclerosis, diabetes, and aging
Quercetin rhamnoside-hexoside	 Quercetin rhamnoside-hexoside $C_{21}H_{19}O_{12}^-$	Antioxidant, carcinogenesis, dermal wound healing, neurodegeneration, atherosclerosis, diabetes, and aging
2-Caffeoyl tartaric acid	 $C_{13}H_{12}O_9$	immunomodulatory activity
Rutins	 $C_{27}H_{30}O_{16}$	Antioxidant, dermal wound healing,

Kumar *et al.* (2010) also reported that the activities of some plant constituents with compound nature of flavonoids, palmitic acid (hexadecanoic acid, ethyl ester and nhexadecaonoic acid), unsaturated fatty acid and linolenic (docosatetraenoic acid and octadecatrienoic acid). terpenoids, flavonoids, saponins, tannins and alkaloids, Glycosides. **Bharathy *et al.* (2012)**analyzed that the Phytol is a diterpene with antimicrobial properties, significantly against many bacterial strains

Bioactive phenolic compounds in *Adiantum* leaves

The phenolic compound were identified by various tools is mentioned in literature given in table 2.

Antifungal Activity

The water extracts and extracted phenols from gametophytes and different parts of sporophytes of, *Adiantum capillus-veneris* L. was investigated for its antifungal activity and found to be bioactive against *Aspergillus niger* and *Rhizopus stolonifer*. Antifungal activity was found to be higher in gametophytes. Among the different parts of sporophytes, immature pinnule possesses highest fungi static property **(Ranjan *et al.*, 2014).**

Antioxidant activity

Antioxidant potential of leaf extract of *Adiantum capillus-veneris* Linn was studied in vitro by Anil Kumar, against H2O2 induced oxidative damage in peripheral blood lymphocytes. Pre-treatment with plant leave extract for 18 hours could effectively inhibited lipid peroxidation and enhanced the activities of antioxidant enzymes and glutathione content significantly. The results indicate that it might be due to its direct action in scavenging free radicals and

thereby modulating the antioxidant defense system **(Sultan *et al*., 2012).**

Antibacterial activity

Pradeep et al., (2010) investigated the *in vitro* antibacterial activity of twelve important pteridophytes plants by disc diffusion method. The aqueous and alcoholic leaves extract of *Adiantum capillus-veneris* Linn were found to be effective against *Agrobacterium tumefaciens, Escherichia coli, Salmonella arizonae, Salmonella typhi* and *Staphylococcus aureus* strains of Bacteria.

Anti inflammatory activity

Alcoholic extract of *A. capillus-veneris* and its hexane fraction showed a significant anti-inflammatory activity against formalin induced inflammation. The hexane fraction and compounds 3, 4 showed topical anti-inflammatory activity after 6 h and continued for 30 h in croton oil- induced inflammation **(Jain *et al.*, 2014).**

The ethyl acetate fraction of the ethanolic extract of *A. capillus-veneris* showed significant inhibition of hind paw oedema induced by carrageenan when evaluated for its anti-inflammatory activity (**Chimie *et al*., 2015.**

Analgesic activity

The analgesic activity of the ethanolic extract of *A. capillus-veneris* and its fraction has been carried out by tail flick method and writhing test result showed significant analgesic activity with insignificant ulceration as compared to the standard drug (**Chimie *et al*., 2015).**

Hypoglycemic activity

The alcoholic extract of *A. capillus-veneris* showed a significant hypoglycaemic effect in OGTT using rabbit model. Started after 30 min and continued for 4 hours (**Jain *et al.*, 2014).**

Lithotriptic activity

In vitro antilithiasic activity of hydro alcoholic extract of *Adiantum capillus-veneris* was evaluated by crystallization, aggregation and nucleation assays. The result showed significant inhibition of crystallization and aggregation which was further confirmed by *in vivo* study against Ethylene glycol (0.75%) and ammonium chloride (1%) induced Urolithiasis in male Sprague Dawley rats. Urine microscopy showed significant reduction in the number of crystals in test groups **(Vijayalakshmi & Kiran Kumar, 2013).**

Anti-diabetic 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 is because of its repair capacity on hepato-renal damaged cell. The reason for increase in serum amylase is due to insulin-like constituents in the species which affect pancreas activity for amylase secretion (**Sultan *et al*., 2012**). Apart from all, it was declared that the species displayed antihyperglycemic property compared to acarbose as reference drug (**Kasabri *et al*., 2017**).

Neuropharmacological activities

Neuropharmacological activities of the plant ethanoic extract were analysed by using different methods. The plant revealed significant anticonvulsant effect through exposure for long durationon the onset of action and reduction in the period of seizures in PTZ-induced convulsion model and in addition by decrease in the time of different phases of seizure through MES-induced seizure method.

In mice forced swim assay, the species 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 effect

The hypocholesterolemic effect by water extract of *A. capillus-veneris* was analysed by using high cholesterol diet (HCD) fed model in rats. The results revealed strong reduction of total cholesterol (TC), LDL and VLDL serum levels with no effect on HDL level. Additionally, atherogenic index of TC/HDL was approximately normalized in rats that were treated with *A. capillus-veneris* (**Chimie *et al*., 2015**).

Antiobesity effect

The water extract of aerial parts of the herb showed phospholipase inhibitory effect through an *in vitro* model which was analagous to orlistat. Chlorogenic acid is also found as the most responsible phytoconstituent (**Kasabri *et al*., 2017**).

Goitrogenic and anti-thyroidal effects

It has been demonstrated that after using the plant, thyroid gland weight generally decreased, although thyroid peroxidase action, antioxidant enzymes, T4 and T3 serum levels increased in animals; however it was observed that TSH serum level decreased strongly **(Vijayalakshmi & Kiran Kumar, 2013).**

Antibacterial and antifungal activities

A previous study by **Dildar et al., (2005)** demonstrated that the *Pseudomonas aeruginosa* was the most susceptible, and the aqueous and methanolic extracts showed a somewhat higher efficiency against this pathogen than the drug amoxicillin.The antibacterial activity of Maidenhair fern against multidrug resistant (MDR) bacteria strains was demonstrated through disc diffusion method. Methanol extract of the leaves species showed maximum zone of inhibition against *Providencia, Klebsiella pneumoniae, Shigella, Vibrio cholera, Staphylococcus aureus, Proteus vulgaris* and *Salmonella typhi*. Stem methanol extract was very high against *Escherichia coli, K. pneumonia* and *S. typhi*. Leave water extract of the species was very strong against all bacteria strains but

its stem water extract revealed minimum ZI against *E. coli, K. pneumonia, S. typhi, Shigella, Proteus 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**). Study of crude and phenolic extracts of gametophyte and sporophyte of the plantwere analysed forantibacterial properties. The gametophytic part of the plant showed significant antibacterial effect. Gram-positive species like *Bacillus subtilis* revealed more susceptibility to both extracts (**Guha *et al.*, 2004**). Additionally, the ethanolic extract of Maidenhair fern aerial parts have no antimicrobial potential against three pathogen bacteria including *E. coli, Staphylococcus aureus* and *Pseudomonas aeruginosa* (**Besharat *et al.*, 2009)**. Different extracts of all used parts revealed that they posses potential for antibacterial and anti-fungal properties **(Ishaq *et al.*, 2014).**

Wound healing property

In anin-vitro study, 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. Besides, aqueous and butanol fractions showed important protection against damage to fibroblasts by oxygen free radicals (**Nilforoushzadeh *et al.*, 2014**). Another research study found that an ointment that consists of Maidenhair fern, Aloe vera, Henna and Myrrha cured wounds in diabetic rats (**Galehdari *et al*., 2016**).

Anti testosterone-induced hair loss effect

Through testosterone-induced alopecia model in mice the hair growth- promoting effect of ethanolic extract of Maidenhair fern was demonstrated. The results shows significant increase in follicular density and anagen/telogen ratio (**Noubarani *et a*l., 2014**).

Antioxidant activity

Ultrasonic-assisted flavonoid extract of the plant has been evaluated for the antioxidant capacity. *In vitro* assays were done through DPPH, scavenging ability of superoxide anion, chelating capability of ferrous ion and reducing power tests. In vivo study was done by using acute mice liver injury experiment. The results showed Maidenhair fern as more potential as antioxidant than other some synthetic antioxidants such as BHT, EDTA, and ascorbic acid. *In vivo* demonstrated significant decrease in superoxide dismutase (SOD), catalase (CAT) and glutathione (GSH) levels and remarkable increase in malondialdehyde (MDA) levels **(Kumar *et al.*, 2010).** In another in vitro examination ethanolic extract of *A. capillus-veneris* leaves has demonstrated its activity against hydrogen peroxide-induced oxidative damage in peripheral blood lymphocytes. The results showedobstruction of lipid peroxidation and elevation in the level of antioxidant enzymes including SOD, CAT, Gpx and glutathione content (**Bharathy *et al.*, 2012**).In vitro study, antioxidant activity of the plant essential oil was confirmed through DPPH assay. Antioxidantproperty of the essential oil is because of phyto-constituents such as carvone, carvacrol, and thymol (**Khodaie *et al.*, 2015).**

Urinary tract effect

The water extract efficacy of *A. capillus-veneris* was assessed on urinary tract. The study showed inability of the bacterial species to grow in this experiment. Systemic *Candida albicans* infection modelwas used in mice to evaluate the protective activity of the plant. It also minimises thecolony-forming units(CFU)of *C. albicans* in the spleen and enhancing the renal pathological characteristics. It also displayed double effects on diuresis activity. The low dosage mostly raised the urinary output and high dose remarkably reduced the urinary output. *A. capillus-veneris* can be used for treatment of urinary tract infection (UTI) (**Ahmed *et al.*, 2013**). In another study, hydroalcoholic extract of *A. capillus-veneris* was evaluated for anti-calcium oxalate urolithiasic property by male rats and found that there was significant decrease in the number of crystals and reduction in the serum level of calcium, phosphorous and blood urea (**Ahmed *et al.*, 2013**). The effect was also confirmed by vitro study. The plant controlled the crystallization, crystal aggregation, and limiting the number and the sizes of crystals (**Haider *et al.*, 2011).**

Anti-inflammatory activity

The ethyl acetate fraction of the plant ethanolic extract has displayed significant anti-inflammatory activity related to the inhibition of NO release and reducing in TNF-α level. Triterpenes may play chief role in the anti-inflammatory property of the plant **(Yuan *et al.*, 2013).**In an in- vitro study, the anti-inflammatory activity of the plant ethanolic extract was analysedvia. lipopolysaccharide-induced prostaglandin E2 generation in RAW 264.7 macrophage and interleukin 6 and tumor necrosis factor generation in the human monocyte model. The plants remarkable anti-inflammatory property is because of suppressing effect on nuclear factor kappa B activation, due to inhibitory effect on the production of inflammatory cytokines (**Janbaz *et al.*, 2015**). In another study, two triterpenoids including 30-normethyl fernen-22-one and 4-α- hydroxyfilican-3-on that isolated from fronds ethanolic extract presented immense potential of anti-inflammatory activity by carrageenan-induced hind paw edema test in rat (**Haider *et al.*, 2013**).

Analgesic and antinociceptive activities

Maidenhair fern hasconfirmed the analgesic effect of the ethyl acetate fraction of the ethanolic extractthrough tail-flick and writhing methods (25). Similar researchestablished powerful analgesic effect of Maidenhair fern through hot plate and tail immersion tests in mice (**Jain *et al.*, 2014**). In addition, 4-α- hydroxyfilican-3-on that isolated from ethanolic extract of the plant showed remarkable anti nociceptive activity in writhing test (**Haider *et al.*, 2013**).

Antidiarrheal and antispasmodic activities

In a study, the crude extract of dried leaves of *A. capillus-veneris* wasassessed for antidiarrheal and antispasmodic capacities. 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 Kumar *et al.*, 2012).**

Anti-asthmatic activity

A. capillus-veneris leaves authenticated anti-asthmatic effect of the ethanolic extract through histamine aerosol-induced asthma in guinea pig. Traditional use of herb already mention it as anti-asthmatic agent **(Yousaf *et al.*, 2016).**

Detoxification activity

Crude extract of Maidenhair fern has showed it as powerful protection through bisphenol A-induced reproductive system toxicity in rats **(Kanchan, 2013)**. Besides, the ethanol extract of the plant at 500 mg/kg doses after 14 d therapy, shows remarkable nephroprotective activity against cisplatin-induced nephropathy (**Alwan *et al.*, 1989)**.

Toxicity and adverse reactions:

In course of an in vitro study, the effects of the ethanolic and aqueous extracts of maidenhair fern on aryl hydrocarbon hydroxylase (AHH) and epoxide hydrolase (EH) enzyme activities, which are responsible for increasing conversion of carcinogenic compounds like poly aromatic hydrocarbons to active components, were evaluated. Both plant extracts showed no inhibitory effect on AHH and EH enzymes (**Haider *et al.*, 2011).**

Toxicity study of Maidenhair fern ethanolic extract was carried out in rat. The results demonstratedbehavioral reactions in rats at the dose of 300 mg/kg. But no mortality was observed after 72 h (**Yuan *et al.*, 2013**).

Crude extract of Maidenhair fern at 1, 3 and 7 g/kg was given orally in mice. No indications of acute toxicity including seizure, piloerection and restlessness were observed after 6 h. Moreover, after 24 h no mortality was seen in mice **(Swaroop Kumar *et al.*, 2012).**

Acute oral toxicity studies of the aqueous and methanolic extracts were done in rat. Acute dosage was 2000 mg/kg as single dose. After first 30 min, 4 h and 24 h after ,important changes in behavior and death were analysed. Both extracts exhibited no major changes in behavior as well as no lethality **(Ranjan *et al.*,2014).**

For evaluation of acute toxicity, ethanol extracts of the species at the oral doses of 1000 and 2000 mg/kg were given to mice. After 24 h no sign of behavioral changes or mortality was seen **(Vijayalakshmi & Kiran Kumar, 2013)**. However, the plant should not be used during lactation period because of no available data. The plant is also contraindicated in pregnant women (**Gruenwald *et al.*, 2008).**

USES DESCRIBED IN TRADITIONAL MEDICINES

Medicinal uses are notdescribed in pharmacopoeias and well established documents or reports. Uses in any clinical data have also not been reported.

It has been used in cold, tumors of spleen, liver and other viscera, skin diseases, bronchitis and inflammatory diseases. It is also considered as tonic and diuretic. Oral application of the fronds decoction was reported to be useful for cleansing respiratory system, dyspnoea, asthma, coryza and chest pain in the field of respiratory system. 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 it is useful for dandruffs.In Nepal, a paste made from the fronds is applied to the forehead to relieve headaches and to the chest to relieve chest pains **(Shirazi *et al.*, 2011**).

The decoction of leaves is taken for acute bronchitis and fever. The fronds are used against cough and cold and also chewed in the treatment of mouth blisters. Fronds extract mixed with honey is used as an eye ointment. It is used as stimulant, fibrifige, expectorant, purgative, demulcent and hair tonic. It has anticancerous, hypoglycaemic, aphrodisiac, antibacterial, antifungal and antiviral properties.

Electrohomeopathy uses

-Act as diuretics and expectorant

-Used in pettorale **(Gruenwald *et al.*, 2008), (Khodaie et al., 2015), (Haider *et al.*, 2013), (Kumar *et al.*, 2014), (Sultan *et al.*, 2012), (Chimie *et al.*, 2015).**

Ayurvedic uses

The plant is used in Ayurvedic system of medicine for certain health conditions such as cold, tumors of the spleen and liver, skin diseases, bronchitis, and inflammation **(Singh *et al.*, 2008**). The extracts of the leaves have strong anti-microbial activities **(Singh *et al.*, 2008; Reinaldo *et al.*, 2015).** The hydro-alcoholic extract of leaves has strong anti-urolithic properties that are usually claimed **(Ahmed *et al.*, 2013).** Among the medicinal properties of Adiantum leaves, anti-inflammatory and analgesic effects **(Haider *et al.*, 2011)** are driving the attention of phytochemists to look for other chemical constituents that might be of the potential biological interest. For example, Adiantum leaves extract contains high level of flavonoids were a good source of antioxidants **(Jiang *et al.*, 2011)**. **Reddy *et al.* (2001**) isolated new terpenoids that was 22,29-epoxy-30-norhopan-13-ol from the Adiantum leaves with strong anti-bacterial activity. Phytochemical analyses of Adiantum leaves revealed the presence of flavonoids, alkaloids, tannins, saponins, glycosides, steroids, and terpenoids with anti-bacterial and anti-fungal activity (**Ishaq *et al.*, 2014).** Limited studies showed the phenolic profile of the Adiantum leaves. For example, **Yuan *et al.*, (2012**)

identified seven bioactive compounds, containing 3-coumaroylquinic acid, kaempferol-3-glucosides as major phenolic compounds. Similarly, quercetin, quercetin-3-glucoside and quercetin-3-rutinoside were then identified in the leaves and extracts were found helpful against inflammation and hypoglycemia **(Ibraheim *et al.*, 2011).**

Useful analgesic due to higher terpenoid flavonoid

The anti-inflammatory and analgesic activities of 300 mg/kg (oral) ethanol extract from *A. capillus-veneris* in rats were proved via comparison of this extract with appropriate standards: indomethacin (20 mg/kg, orally) after 3 h and ibuprofen (same dose) after 2 h, respectively.

Adverse Effect – there is no report has shown a significant adverse effect of oral intake of *Adiantum capillus-veneris.*

REFERENCES

[1]. Ahmed A, Bilal A, Hajera S, Jahan N, Wadud A. 2013. In vitro effect of hydro alcoholic extract of *Adiantum capillus-veneris* L. on calcium oxalate crystallization. IJGP, 7(2):106–110.

[2]. Ahmed A, Wadud A, Jahan N. 2013. Efficacy of *Adiantum capillus-veneris* L. in chemically induced urolithiasis in rats. J Ethnopharmacol, 146(1):411–16.

[3]. Alwan AH, Al-Gaillany KAS, Naji A. 1989. Inhibition of the binding of 3 h-benzo [a] pyrene to rat liver microsomal protein by plant extracts. Int J Crude Drug Res, 27(1):33–37.

[4]. Besharat M, Rahimian M, Ghaemi E, Besharat S. 2009. Effect of ethanolic extract of *Adiantum capillus-veneris* in comparison with Gentamicine on 3 pathogenic bacteria in vitro. Pharm Sci, 15(1):49–52.

[5]. Bharathy V, Maria Sumathy B, Uthayakumari F. 2012. Determination of phytocomponents by GC-MS in leaves of *Jatropha gossypifolia*. Science Research Reporter, 2(3):286-290.

[6]. Chimie RRD, Al-hallaq EK, Litescu SC. 2015. Hypocholesterolemic Effects of *Adiantum capillus-veneris* L. aqueous extract in high Cholesterol diet-fed rats and HPLC-MS determination of its polyphenolics. Rev Roum Chim, 60(4):357–65.

[7]. Gruenwald J, Brendler T, Jaenicke C. 2008. PDR for herbal medicines. Montvale: Medical Economics Company

[8]. Guha P, Mukhopadhyay R, Pal PK, Gupta K.2004. Antimicrobial activity of crude extracts and extracted phenols from gametophyte and sporophytic plant parts of *Adiantum capillus-veneris* L. Allelopath J, 1:57–66.

[9]. Haider S, Kharbanda C, Alam MS. 2013. Anti-inflammatory and anti-nociceptive activities of two new triterpenoids from *Adiantum capillus-veneris* L. Nat Prod Res, 27(24):2304–2310.

[10]. Haider S, Nazreen S, Alam MM. 2011. Anti-inflammatory and anti-nociceptive activities of ethanolic extract and its various fractions from *Adiantum capillus-veneris* L. J Ethnopharmacol, 138(3):741–47.

[11]. Galehdari H, Negahdari S, Kesmati M, Rezaie A, Shariati G.2016. Effect of the herbal mixture composed of *Aloe Vera*, *Henna*, *Adiantum capillus-veneris*, and *Myrrha* on wound healing in streptozotocin-induced diabetic rats. BMC Complement Altern Med, 16:386.

[12]. Ibraheim ZZ, Ahmed AS, Gouda YG.2011.Phytochemical and biological studies of Adiantum capillus-veneris L. Saudi Pharm J ; 19: 65–74.

[13]. Ishaq MS, Hussain MM, Afridi MS.2014. *In vitro* phytochemical, antibacterial, and antifungal activities of leaf, stem, and root extracts of *Adiantum capillus-veneris*. ScientificWorldJournal:269-793.

[14]. Jain SK, Singh T, Pande M, Nema N.2014. Neuropharmacological screening of fronds of *Adiantum capillus-veneris* L. Pharm Lett, 6(3):167–75.

[15]. Janbaz KH, Hassan W, Mehmood MH, Gilani AH. 2015. Antidiarrheal and antispasmodic activities of *Adiantum capillus-veneris* L. Bangladesh J Pharmacol, 10(1):222–29.

[16]. Jiang M-z, Yan H, Wen Y, Li X-m. 2011. In vitro and in vivo studies of antioxidant activities of flavonoids from *Adiantum capillus-veneris*L. Afr J Pharm Pharmacol, 5(18):2079–85.

[17]. Kanchan G. 2013. Protective effect of *Adiantum capillus* against chemically induced oxidative stress by cisplatin. J Appl Pharm Sci, 3(2):65–68.

[18]. Kasabri V, Al-Hallaq E, Bustanji Y.2017. Antiobesity and antihyperglycaemic effects of *Adiantum capillus*-veneris extracts: in vitro and in vivo evaluations. Pharm Biol, 55(1):164–172.

[19]. Khodaie L, Esnaashari S, Bamdad Moghaddam S.2015. Essential Oil of Arial Parts of *Adiantum capillus-veneris*: Chemical Composition and Antioxidant Activity. J Nat Pharm Prod, 10(4):3–7.

[20]. Kumar A. 2009. Antioxidant Effect of *Adiantum capillus-veneris* L. on human lymphocyte : an in vitro study. J Cell Tissue Res, 9:1899–902.Kumar S, Samydurai P, Ramakrishnan R, Nagarajan N.2014. Gas chromatography and mass spectrometry analysis of bioactive constituents of *Adiantum capillus-veneris* L. Int J Pharm PharmSci, 6(4):60–63.

[21]. Kumar, V., Sachan, P., Nigam, G., Singh, P.K. 2010. Some ethno-medicinal plant of Chitrakoot district (U.P.). Biozone Int. J. Life Sci., 2(1 2): 270 283

[22]. Marico Auerilo Ziemann dos santos, Tatiana Valesca Rodriquez Alicieo, Claudio M.P. Pereira, Guillermo. Ramis-Remos, CarloR.B Mendonca. 2014 Profile of bioactive compounds in

Avocadopulpoil: Inflluence of the Drying processes and extraction methods. Journal of the American oil chemists society. 91(1)

[23]. Medrar Hussain M, Ahmad B, Rashid E. 2014. In vitro antibacterial activity of methanol and water extracts of *Adiantum capillus-veneris* and *Tagetes patula* against multidrug resistant bacterial strains. Pak J Bot, 46(1):363–68.

[24]. Nilforoushzadeh MA, Javanmard SH, Ghanadian M.2014. The Effects of *Adiantum capillus – veneris* on wound healing : An experimental *in vitro* evaluation. Int J Prev Med, 5(10):1261–8.

[25]. Noubarani M, Rostamkhani H, Erfan M.2014. Effect of *Adiantum capillus-veneris* linn on an animal model of testosterone-induced hair loss. Iran J Pharm Res, 13(Suppl):113–118.

[26]. Pradeep Parihar, Leena Parihar and Achaleshwar Bora. 2010 In vitro antibacterial activity of fronds (leaves) of some important pteridophytes. Journal of microbiology and antimicrobials; 2(2): 19-22.

[27]. Ranjan V, Vats M, Gupta N, Sardana S. 2014. Antidiabetic potential of whole plant of *Adiantum capillus-veneris* L. instreptozotocin induced diabetic rats. IJPCR, 6(4):341–47.

[28]. Reddy V.L, Ravikanth V, Rao, T.P, Diwan, P.V, Venkateshwar Y.2001. Anew triterpenoid from the fern *Adiantum lunulatum* and evaluation of antibacterial activity. Phytochemistry 56, 173-175.

[29]. Reinaldo RCP, Santiago ACP, Medeiros PM, Albuquerque UP.2015. Do ferns and lycophytes function as medicinal plants? A study of their low representation in traditional pharmacopoeias. J. Ethnopharmacol, 175: 39- 47

[30]. Singh M, Singh N, Khare PB, Rawat AKS. 2008. Antimicrobial activity of some important Adiantum species used traditionally in indigenous systems of medicine. J. Ethnopharmacol, 15: 327-329

[31]. Sultan AH, Dizaye KF, Hiwa BB.2012. Histological, Immunocytochemical and Biochemical Study of the Effect of *Adiantum capillus* on Alloxan Induced Diabetic Rats. MEJIM, 5:3–12.

[32]. Shirazi MH, Amin G, Lavasani BA, Eshraghi SS. 2011. Study of antibacterial properties of *Adiantum capillus-veneris* extract on eight species of gram positive and negative bacteria. J Med Plants, 10(40):124–32.

[33]. Swaroop Kumar K, Anbu J, Anjana A. 2012. Influence of ethanolic leaf extract of *Sargassum wightii* and *Adiantum capillus* on histamine induced asthma in animal model. Int J Pharm PharmSci, 4(Suppl 4):121–23.

[34]. Vijayalakshmi A, Kiran Kumar Y. 2013. Evaluation of goitrogenic and antithyroidal effect of the fern *Adiantum capillus-veneris*. Rev Bras Farmacogn, 23(5):802–10

[35]. Yousaf B, Amina, Liu G. 2016. Bisphenol A exposure and healing effects of *Adiantum capillus-veneris* L. plant extract (APE) in bisphenol A-induced reproductive toxicity in albino rats. Environ SciPollut Res Int, 23(12):11645–57.

[36]. Yuan QY, Ruan JL, Cai YL.2010. Effect of water extracts of *Adiantum capillus-veneris* L. on urinary tract infections. Chin Pharm J, 45(18):1389–92.

[37]. Yuan Q, Zhang X, Liu Z. 2013. Ethanol extract of *Adiantum capillus-veneris* L. suppresses the production of inflammatory mediators by inhibiting NF-κB activation. J Ethnopharmacol, 147(3):603–11.

[38]. Yuan Q, Wang J, Ruan J. 2012.Screening for bioactive compounds from *Adiantum capillus-veneris* L. J Chem Soc Pak ; 34: 207–216.