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Actinopteris Radiata (LINN.): An Updated Critical Review

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Abstract: ***Actinopteresradiata (Linn.) is an important medicinal plant belonging to the xerophytic species of the fern family Actinopteridaceae. The plant is used in Indian -traditional medicine which is utilized in treatment of various disorders. This fern is currently available in a large number of countries such as India, Africa, Australia, Madagascar, Saudi Arabia, Iran, Sri Lanka, Afghanistan, Nepal, etc. Synonyms are Morpankhi, Peacock's tail, Mayurishika, Nemaliadugu, A.australis, A.dichotoma. It is categorized among the extinct species and fast disappearing plants. The fern is abundant in phenolic compounds, tannins, flavonoids, glycosides, steroids, hydrocarbons, coumarins and triterpenoids. A. radiata is reported to have many phytoconstituents out of which major phytoconstituents are Hentriacontane, Hentriacontanol, Hentricontanone, β-sitosterol, Quercetin-3-rutinoside (rutin), β-sitosterol palmitate and D-glucoside. Anti-histaminic, anti-cholinergic, anti-tubercular, anti-helminthic, anti-inflammatory, anti-microbial, hepatoprotective, anti-epileptic, anti-diarrhoeal, anti-fertility, analgesic, styptic, anti-oxidant, anti-stress, anti-allergic and anti-typhoid are the activities of the fern. A 50% ethanolic extract of the plant is used to prepare safe male contraceptive pills. It is also given as a dietary supplement in treatment of malnutrition patients. It is known to take off heavy metals from the rhizosphere by phytoremediation method. The present review is an insight into thephyto-constituents and major pharmacological activities of A. radiata. The updated review is an attempt to summarize the ethnobotanical, phytocchemical and pharmacological activities of the plant which establish a scientific basis for medicinal use of this plant along with the need to explore the plant for further research to be carried as potential discovery of novel natural bioactive compounds.***

Keywords: Actinopteres radiata Linn, Quercetin-3-rutinoside, anti-tubercular activity, anti-microbial activity, anti-inflammatory activity

1. Introduction

From the ancient human civilization the actual history of herbal medicine began. Man acquainted himself with plants which he used them in different ways for years. He then began to differentiate between plants which can be used as food for nourishment purpose and the plants which have definite pharmacological actions. So the use of plants as medicinal plants is as old as the human civilization. There are number of different ancient medicinal systems such as Unani, Naturopathy, Homeopathy, Ayurveda and others. All these ancient medicinal systems use plants as effective source to treat different types of diseases. Herbal medicine is used as an alternative to synthetic medicines and also played a very important role in public health care in various countries, especially in Asia.

Actiniopterisradiata is a small xerophytic fern found all over India. It is also called as Mayurishikha. It is of limited distribution and is present in the restricted areas such as steep slopes of exposed hilly areas up to altitude of 1200m above msl and also found on depleted walls. A.radiata is an important medicinal plant belonging to the xerophytic species of the fern family Actinopteridaceae which have great medicinal value. The plant is used in Indian - traditional medicine which is utilized in treatment of various disorders. This fern is currently available in a large number of countries such as India, Africa, Australia, Madagascar, Saudi Arabia, Iran, Sri Lanka, Afghanistan, Nepal, etc. Synonyms are Morpankhi, Peacock's tail, Mayurishika, Nemaliadugu, A.australis, A.dichotoma. It is categorized among the extinct species and fast disappearing plants. According to the Ayurvedic literature Mayurishikha (A.radiata) is used as tonic to genitourinary tract ,anti-histaminic, anti-inflammatory, anti-cholinergic, astringent, anti-tubercular, anti-microbial, alleviates vitilated blood, also used in cough, bronchitis, diarrhea, dysentery, dysuria etc. It is known to have styptic and anti-helminthic property. It is used internally as well as externally for ulcer, infected wounds and erysipelas.

History:

Hemadri in the year 1992 reported the medicinal uses of Actiniopteris radiate for relieving itching. Interestingly Vijaykumar and Pullaih reported tha root of Mayurishikha promotes fertility in the 1998. K.Thulsi Rao et al. have reported that this plant is used for controlling tuberculosis , controlling blood pressure and also in case of controlling cough by Chenchu tribe who are inhabitants of Nallamallaih hill of Andhra Pradesh, India. Most of the activity studies of this plant were reported in 1970s.

Geographical Distribution:

A.radiata is also known as Peacock's tail which belongs to the family Actiniopteridaceae. It is a tiny xerophytic fern which grows in all over India. It is also found in many other countries such as Sri Lanka, Afghanistan, Persia, Arabia, Yemen, Burma, South Eastern Egypt, Tropical Africa and Madagascar. A.radiata grows well in reddish or black gravelly soil (pebbly, gritty). Its distribution is limited and is

mainly found in crevices of rocks of steep slopes of exposed hilly areas or in between the bricks of the wall, along roadsides and especially in altitudes (distance measurement usually in vertical or up direction) of 1200 m6. Some of the plant was also collected from Golconda fort walls, about 900gms was collected.

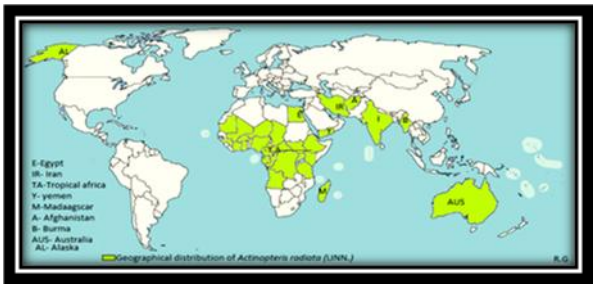


Figure 1: Geographical distribution of Actiniopteris radiata (Linn.)

Plant Profile:
Actiniopterisradiata(linn.) (RAY FERN)
Family: Pteridaceae

Taxonomical Classification:
A simpler classification and taxonomical position of Actiniopterisradiata (linn.) is given:
Super Kingdom: Eukaryota
Sub kingdom: Viridiplantae
Phylum: Embryophyta
Class: Filicopsida
Order: Filicales
Family: Pteridaceae
Sub family: Actiniopteridaceae
Genus: Actiniopteris
Species: radiata
Binomial name: Actiniopterisradiata

As stated in NCBI taxonomy, subfamily Actiniopteridaceae have four major species under it they are Actiniopterisdimorpha(which further have 2 sub species they are A. dimorpha and A. diyersiformis), Actiniopterispaucibola, Actiniopterisradiata and Actiniopterissemifbellata.

Synonyms:
1) Sanskrit - Mayurishikha
2) Telugu - Nemaliadugu
3) English - Peacock's tail
4) Bombay - Mapursika
5) Hindi – Morpankhi
6) Tamil – Mayilatumshikhai
7) Kerala – Nanmukhappullu
8) Acrostichumradiatum (J.Konig ex Sw.) Poir
9) Actiniopterisaustralissensu Sim
10) AspleniumradiatumJ.konig ex Sw.
11) Pterisradiata (J.konig ex Sw.) Bojer

Botanical Description:
The ferns are 8-25cm high rooting. Rhizomes are oblique to horizontal, 1.5 to 2.0cm in length and are densely covered with hairy roots, leaf bases and palea. The young leaves of A.radiata showscircinate vernation and at early stage of development the lamina of the leaf becomes flat. When we touch the laminae they are stiff and rough. The sporangia are mostly sub-marginal and the inter-marginal vein covers nearly the entire biaxial surface of segment.

Fern Structure and Morphology:
Rhizomes act as stems in all pteridophytes. All the ferns have stems and leaves which are called as fronds and roots. They are found below the rhizome, they climb on other big plants or they creep on the ground. Although they are no flowers in the whole life cycle of Actiniopterisradiata (Linn.)and in other ferns. In ferns there is no fruit and seed production. The major difference between pteridophytes and the other higher plants is that vegetative propagation is through rhizome, sexual production of these species is through spores. Pteridophytesand Actiniopterisradiata (Linn.) are habitually found in dry and hot deciduous woodlands with perennially high temperatures and low rainfall ranging from 500m-1300m. They basically grow in crevices of rocks, deep soils and also in shady places. Actiniopterisradiata (Linn.) general parts and their description is given below:

Rhizome: It is dark brown or blackish in color and is usually prostate, oblique short round and dimorphic. Length ranging from 1.5 to 2.0cm and are densely covered with hairy roots (wiry) and leaf bases.

Laminae: They are fan shaped and spread to about 180 degrees and are 15-45mm long. The tip of each segment bears 2-5 teeth laminae are which are referred to as leaves and are also known as fronds .These fronds consists of leaf stalk and often multi pinnate leaf sheet. The vascular system of these leaves are branching, hence they are termed as macrophyllus. The young leaves show circinate venation (coiled when young) but the lamina of the leaves becomes flat at an early development stages.

Stem: The stem is usually very short or else it is under the ground as rhizome from which root sprouts. It is small xerophytic plant and is about 8-25cm high rooting found in the crevices of the rocks, in the joints of the walls and along the roadside. These plants are generally found in alluvial soil or lime rich. Under the leaves we can find some clusters of spores (sorus, plural-sori) but the first sorus will have sporangia lining. These clusters of spores are covered with protective lining which is known as Indusium. Spores are ball shapes and consists of sporangia tissue and it is covered by thick wall calles as annulus. Conversion of sporangia in to spores occurs through meiosis leading to the formation of haploid spores.

Figure 2: Plant parts of Actiniopterisradiata (Linn.): Fronds, Rhizome and stem.

Microscopic features of Actiniopterisradiata (Linn.):
Mature diploid sporophyte is best known stage of the life cycle. Leaves are also known as fronds and are in multi-pinnate style. The stem is short and it is entirely below the ground level, rhizome is also present from which the roots arises. In the cross section of this plant you can identify epidermis layer, cortex, and cylinder consisting of vascular bundles. On the plant you can see ball shaped sporangia which undergo meiosis and forms haploid spores.

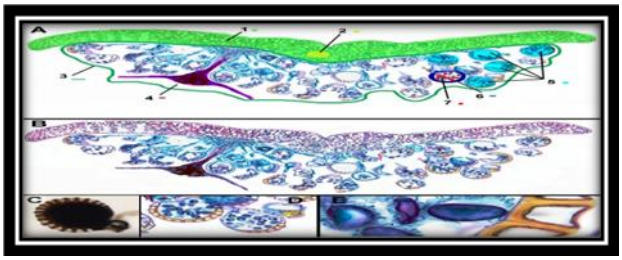


Figure 3: Cross section of a leaflet (Fern).
A and B is the cross section through the leaflet of a true fern.
1.Frond 2. Vascular bundle. 3. Sorus 4. Indusium
5.Sporangia 6.Sporangium wall 7.Spores.
C. Details of spore
D. Detail section through spores.
E. Detail of the wall of a spore.

Phytochemical Studies:
Preliminary phytochemical studies conducted by B.L Hungund and C.H Pathak in the year 1971 exhibited that alkaloids are present in the roots and leaves of Actiniopterisradiata and also said that tannins and saponins are absent in the plant. Although Kshirsagar and Mahta in 1972 revealed that there are no alkaloids in the plant. S. Bambie et al. reported in the same year that ethanolic extract of powdered sporophyte showed the presence of Quercetin-3-rutinoside (rutin). Further work by them and co-workers revealed that the stem and leaves of Actiniopteris contain hentriacontane, hentriacontanol, β-sitosterol palmitate, β-sitosterol, β-sitosterol-D-glucoside and an unidentified glucoside along with glucose and fructose.

Ethnobotanical Uses:
Actiniopterisradiata is used as a dietary supplement in malnutrition, it is also used as a styptic. It is also used in the treatment of acute headache and also in dysentery. 3-5 Whole plant paste is applied on cuts and wounds: past with sugar is given to kill intestinal worms twice for 3 days: paste with sugar is also given two times a day as an aphrodisiac, also used as a tonic to increase the potency. The plant paste with sugar candy is given as a cooling agent in the case of syphilis. The paste of two fronds is given daily two times a day to children to cure rickets. The whole plant paste mixed with cow's milk is given for the treatment of piles and leucorrhoea. Milk is given twice a day for 2-3 days. In the case of epilepsy, plant paste with sugar candy is given. The plant paste with honey is given twice a day for the treatment of leucorrhoea. Plants are soaked overnight in a glass of water and taken orally in the morning for control of blood pressure and tuberculosis. Plants are dried and one teaspoonful powder is taken orally, once a day for four days in the case of cough. The paste of 5-6 leaves mixed with fresh cow milk (nearly 200ml) is taken for a week or so, to overcome irregularly in the menstrual period. The ash (approx. 2-3 g) of the plant mixed with fresh cow milk (200 ml) is given to a lady for a fortnight after menses for conception. On the other hand, the paste of 8-10 leaves mixed with thin curd (nearly 250 ml) is given for birth control. A decoction of leaves is also used in tuberculosis

Pharmacological and Biological Studies:
In 1972, Kshirsagar and Mehta have reported that the methanolic extract of the plant was devoid of antibacterial activity against Bacillus subtilis, Bac cereus, Bac megatherium, Staphylococcus aureus, and E.coli

The only clinical study on Human volunteers for Actiniopteris was reported in 1975 by S.K. Dixit and G.K. Bhatt, Research Institute (Ayurveda) Rajasthan, Jaipur. In this study, the antifertility of the combination of the Mayursikha (vernacular name of Actiniopterisradiata) and NagadBabchi (vernacular name of Ocimumamericanumlinn.) has been studied in 10 healthy volunteers. The drugs have been administered just after the menstrual period for 3 days continuously. (The couples were advised to avoid sexual intercourse during this period).

The Mayursikha has been administered 1 gm dose with 1.5 lb of fresh cow milk and sugar candy. The NagadBabchi has been administered in the evening before meals in 1 gm dose with sugar candy and water. The result was promising since it prevented conception in 9 out of 10 cases. Preliminary observation also suggested that this drug combination is a non-toxic oral contraceptive.

In the next year (1976), K.C. Singhal has reported that the aqueous extract and decoction of the leaves of Actiniopteris dichotomy did not reveal anthelmintic activity against Syphaciaobvelata, Nippostrongylusbrasiliense and Hymenolepis nana in vivo, in mice. Another significant effect on the screening of Actiniopteris came through B. N. Dhawan, G.K. Patnaik et al., just one year later (in 1977).

The 50% ethanolic extract of the plant in a preliminary biological screening was found to be devoid of antibacterial (in Bacillus subtilis, Staphylococcus aureus, Salmonella typhi, E coli, and Agrobacterium tumefaciens), antifungal (in Candia Albicans, Gyptococcusneoformans, Trichophyton mentagophytes, Microsporumcanis, and Aspergillus niger), antifertility (anti-implantation, spermicidal, semen coagulant and abortifacient), hypoglycemic, diuretic, anti-inflammatory activity, respiratory and cardiovascular effects. The LD50 of the extract was found to be 750 mg/kg i.p in mice. A. Sharma et al. have reported an in vivo study on male rats for the antifertility activity of 50% ethanolic

extract of Actiniopteris.34 In this study crude extract of the whole plant of Actiniopteris dichotomy (50% ethanolic extract) and its isolated chromatographic fraction 50:50 (CHCl3: CH3 OH) at the dose level of 50 mg/kg body wt/day for 60 days, induced infertility in male rats.

They have reported that the reduction in fertility is coinciding with suppressed sperm production and reduced sperm motility. The treatment caused degeneration and vacuolation in spermatogenic cells and reduced seminiferous tubule dimensions. The spermatids were declined by 98.0% and 95.6%. Also, the study has shown that the reversibility could be achieved after 8-10 weeks of cessation of the treatment. This important pharmacological study suggested that Actiniopteris dichotomy can be used to develop a safe male contraceptive pill.

Extracts of the Actiniopterisradiata at the concentration of 150 mg/ml and 300 mg/ml were tested against Gram (+) bacteria & fungi. The anti-microbial activity has shown appreciable results due to the presence of tannins, flavonoids, and sterols. The ethanolic and aqueous extract of Actinopterisradiata was investigated in mice to evaluate the analgesic activity by using Acetic acid-induced writhing and the Tail flick method. Administration of Actiniopterisradiata extracts shown potent analgesic activity in the Acetic acid-induced Writhing method, whereas both extracts showed non-significant analgesic activity in the Tail flick method.

Extraction Methods:

The phytochemical constituents of Actiniopterisradiata were extracted by using different solvents such as n-hexane, chloroform, ethyl acetate, and ethanol. The whole plant was collected and washed with tap water followed by drying in the sunshade at 30-40ºC. Then it is grounded to get coarse powder by cutter mill for extraction. The essential constituents are extracted in a Soxhlet extraction apparatus by using ethanol as a solvent.

Phytochemical Constituents:

Actinopterisradiata plant is known to have alkane hydrocarbon chains (hentriacontane, hentriacontanol) and Flavonoid glycoside (quercetin-3-rutinoside) (Rutin). steroidal compounds such as (β-sitosterol, β-sitosterol palmitate, β-sitosterol-D-glucoside) 47are also present and detected they are some glycosides are also present and these glycosides are (2-(3, 4-O – Diglucoscinnamoyl) – 4 – hydroxyl furan and 1-Heptaloyl, 8-hexyl, 3-(O – Diglucos), 10 – methyl, 9. 10 – dihydro naphthalene.).The other Phytochemical are Dec-3-enyl, 2-(heptyloxy)-1-mercaptoethanol terephthalate and 1-(Phenylethy-butanoate ether), 2-(3-ene heptanoate) ethane48. Glucose, fructose, alkaloids, flavonoids, tannins, Saponins, Quinones, Cardio glycosides, Terpenoids, Coumarins, betacyanin, and phenols.

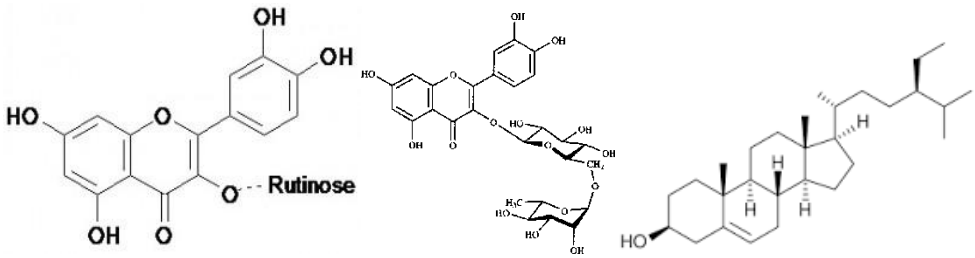
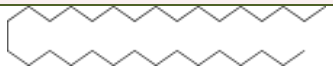
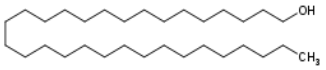
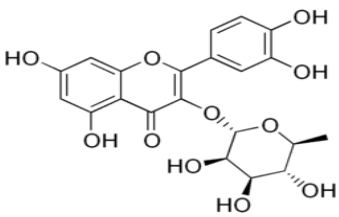
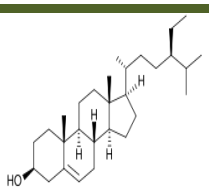
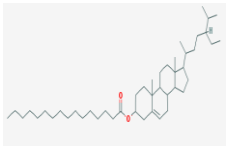
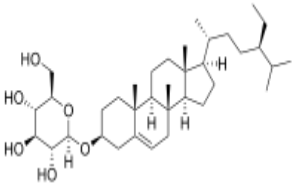
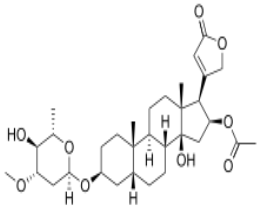
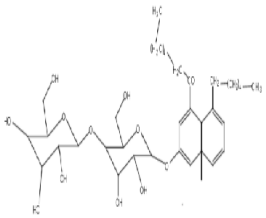
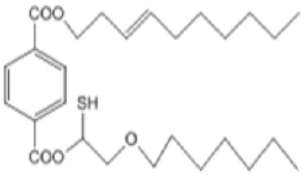


Figure 4: Structures of rutinose, Quercetin-3-rutinoside and Beta-sitosterol.

Chemical Constituents Present In Actinopteris Radiata (Linn).:

Name of the compound	*Structure*	*Importance of these chemical constituents*
ALKANE HYDROCARBON CHAINS: ***• hentriacontane***		*Antitumouragent,anticancer*
Hentriacontanol		*Anti-inflammatory, Antifungal,Antimicrobial, hepatoprotective activity*[52] *improves acute lung injury, protective effect on induced oxidative stress, inflammation, apoptosis.*[53]
FLAVANOID GLYCOSIDES: Quercetin-3- rutinoside		*Anti-inflammatory. Anti-cancer, Anti-carcigenic*[54]
STEROIDAL COMPOUNDS β- sitosterol sitosterol palmitate β-sitosterol-D-glycoside		*Benign Hyperplasia , Blood Cholestrol Level, antiinflammatory, antihyperglacaemic activity, hyperlypedemia.*[54]

GLYCOSIDES: 2-(3,4-O-diglucoscinnamoyl-4-hydroxyl furan)		*Benign Hyperplasia , Blood Cholestrol Level, antiinflammatory, antihyperglacaemic activity, hyperlypedemia.*[54]
1.HEPTALOYL,8 HEXYL 3(O-Diglucos), 10methyl,		*congestive heart failure, heartfailure, arrythmia , Atrial fibrillation, control plasma level.*
9.10-dihydro naphthalene. Dec-3-enyl.(heptyloxy)-1-mercaptpoethyl terephthalate		*Antiinflammatory, purgative,coxinhibitors analgesicscyanogenics*[55]
		*BloodCholestrolLevel,antihyperglacaemic*
		
		

Pharmacological Activites:

However some of the pharmacological investigations have been carried out based on the chemical constituents present in this plant but a lot more can be explored and utilized in a therapeutic manner. A summary of the findings of some of these activities is described below.

Invitro Antihistaminic and Anti cholinergic activity:
The ethanolic extract of whole plant of Actiniopterisradiata (Sw.) Link was tested to evaluate the spasmolytic effect on isolated rat ileum. The crude extract at a dose of 2, 4, 10 mg/ml dose dependently relaxed the rat ileum which was contracted. And maybe due the presence of agonist like histamine and acetylcholine.

Analgesic activity:
The ethanolic and aqueous extract of Actinopterisradiata was investigated in mice to evaluate the analgesic activity by using Acetic acid induced writhing and Tail flick method.. Administration of Actiniopterisradiata extracts shown potent analgesic activity in the Acetic acid induced Writhing method, where as both extracts shown non-significant analgesic activity in Tail flick method. Hence it is indicated that both plant extracts possesses only potent peripheral mediated analgesic activity and inhibits predominantly peripheral pain mechanism. The extracts were found to produce marked analgesic effect due to the presence of alkaloids, tannins, flavonoids and phenolic acid.

Antimicrobial activity:
Anti-bacterial activity Extracts of the Actiniopterisradiata and carallumaadscendens was studied by cup plate method. All the extracts at the concentration of 150 mg/ml and 300 mg/ml were tested against Gram (+) bacteria such Escherichia coli, Shigella, Salmonella typhi, Pseudomonas aeruginosa, Vibrio cholerae, Bacillus subtilis, Kebsiellapnemoniae, Proteus vulgaris and Staphylococcus aureus. The plates were incubated at 370 C for 48 hrs. The diameter of zone of inhibition was calculated after incubation .An average of three independent determinations was recorded.

Antifungal Activity:
Plant extract of Actiniopterisradiata and Carallumaadscendens was evaluated against Candida Albicans, Aspergillus niger and Mucor by Cup-plate method at the concentration of 150 mg/ml and 300mg/ml using Griseofulvin as standard drug. Diameters of the zones of inhibition were determined as an indication of activity after incubating the plates at 25o C for 72 hrs. An average of three independent determinations was recorded. The anti-microbial activity has shown appreciable results due to the presence of tannins, flavonoids and sterols.

Wound healing activity:
The ethanolic extract of the Actinopterisradiata evaluated for its wound healing activity in rats. Wound healing activity was studied using Excision, Incision and Dead space wound models in rats following topical application and compared with a standard 5% w/w Povidone-iodine ointment. 10% w/w Actinopterisradiata ointment was prepared for topical application and 5% w/w Povidone-iodine ointment was used as a standard. On excision and incision wound models the alcoholic extract of Actinopterisradiata produces good wound healing activity and comparable with that of 5% w/w Povidoneiodine ointment. The alcoholic extract of Actinopterisradiata produced dose dependent effect on granulation tissue and hydroxyproline content. The results clearly indicated good wound healing activity.

2. Miscellaneous Studies

a) Study on Phytoremediation:
Phytoremediation, more specifically phytoextraction, attempts to remove contaminants from the rhizosphere through plant uptake and the contaminants are accumulated in roots, leaves and/or stems. The plant materials are then harvested and the contaminants reclaimed from the plant biomass or the materials are disposed of at a hazardous waste facility. Phytoextraction is an organic, low input, and solar energy powered remediation technique that applies to sites with surface and low to medium levels of contamination. The ideal plant for phytoextraction must be able to tolerate high levels of the element in root and shoot cells. Plants used for phytoextraction must have the ability to translocate the contaminant from roots to shoots at high rates. For most plants, root concentrations are much higher than shoot concentrations, but in hyperaccumulators, shoot metal concentrations exceed root. L. Q. Ma et. al. reported that growing fern plants like Actiniopterisradiata, in an environment site containing Selenium pollutant, can remove a portion of the Selenium through phytoremediation with a live part of the plant, wherein the part is a root portion of a frond portion.Out of eleven fern species studied A. radiata was the best species overall for Se accumulation. Another study by the same group revealed that growing fern plants like Actiniopterisradiata, in an environment site containing arsenic pollutant can remove a portion of the arsenic through phytoremediation.

b) Resurrection habit:
Sharma B. D and Purohit S. N have studied the relationship between leaf water deficit and resurrection habit in six species of ferns collected from Rajasthan, India83. Out of these, Actiniopterisradiata showed a maximum 42 resaturation and its leaves revived even at high water deficit. Resurrection habit is a type of xerophytic adaptation.

c) Study of vessels in the rhizome of Actiniopteris:
R. Singh et al. reported the vessel elements in the rhizome of Actiniopterisradiata for the first time. The vessels occur in the nodule region and posses different types of simple perforations at their terminal ends, which may be circular, elliptical and triangular. The lateral walls of the vessels are generally provided with scalariform thickenings. P. Sharma and T. N. Bhardwaj reported that the rhizomes of Actiniopterisradiata regularly posses branched tracheids.

d) Drought resistance studies:
Bohra et al. studied the drought resistance of fern species which survive at Mt. Abu and reported that among them Actiniopterisradiata possess maximum drought resistance. Their observation was based on the study of pigments; drought-resistant species showed lesser degradation of chlorophylls and exhibited higher carotenoids contents. Later on, their findings were supported by D. Rathore and B. D. Sharma through a study of praline about stress in various ferns of Mt. Abu. The study was based on the viewpoint that the accumulation of proline is generally related to stress. Among the various species of Mt. Abu Actiniopterisradiata possess maximum drought resistance. They also reported that aquatic ferns and those whish survive in moist shady places (non-stressed) e.g.:- Marsilea and Asplenium, posses a comparatively lesser amount of proline than those plants which grow on the exposed and dry rocks (stressed) e.g.:- Actiniopterisradiata.

3. Conclusion

The present review is an insight into thephyto-constituents and major pharmacological activities of A. radiata. The updated review is an attempt to summarize the ethnobotanical, phytocchemical and pharmacological activities of the plant which establish a scientific basis for medicinal use of this plant along with the need to explore the plant for further research to be carried as potential discovery of novel natural bioactive compounds. Although preliminary chemical studies are reported in 1970s an extensive study is needed in this area for isolation and characterization of chemical constituents. Most of the chemical characterization studies reported was almost 30 years back. These studies used simple extraction and column chromatography for isolation of chemical constituents and m.p, I.R and routine qualitative tests for identification and characterization. An extensive study using sophisticated equipments like LC-MS, HPLC, HPTLC, NMR etc. may bring out the presence of various other constituents.Another area of interest is the heavy metal content in this plant and its relation to pharmacological activity and other parameters like LD50. The plant has shown to absorb heavy metals like Arsenic from the atmosphere, which have deleterious effects in human beings

A complete exploration and development work should be commenced for preservation of Actiniopterisradiata.

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