Perspectives of Pteridophytes Biodiversity: A Source of Economy Elevation

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Ferns and their allies also known as the vascular cryptogamic plants have enormous aesthetic value and multifarious scope for exploring the bioactive molecules against various pathogenic causal organisms of bacterial, fungal and microbial origins. In view of the evolutionary trends of plants the Pteridophytes have valuable importance to unearth the number of uncertain hypothesis of evolution. In addition, more species of the Pteridophytes have been known and validated as potential genetic resource against many diseases and source of miscellaneous articles. However, the Pteridophytes have long history of their evolution and were known as dominant group of the plants during the carboniferous periods. Since, their dominating era few of the species have survived long and known as relic species (*Psilotum nudum*) playing major role to resolve the phylogenetic relationships and evolutionary trends. Whereas the first attempt to enlist the species composition and their economic importance was made a 2300 years back. Theophrastus (327-287 BC) and Dioscorides (50 AD) mentioned and referred the medicinal attributes of certain ferns, however, in context to India it was Shushruta and Charak who described and narrated medicinal uses of *Marsilea minuta* and *Adiantum capillus-veneris* in their Samhitas. After a long gap of studies, Caius made first effort in 1935 to describe the medicinal uses of some ferns in India and is considered as the first man to take this very initiative of such kind's investigation. Thereafter, Nayar in 1957 and Kaushik & Dhiman in 1995 emphasized and apprehended the medicinal and economic utility of many fern species distributed in India. Many other fern species have been extensively explored and determined to exhibit great economic potential due to some interesting chemical and antimicrobial properties. Braken fern "*Pteris vittata*" has also shown anti-microbial activities while tested against eight bacterial strains of the gastrointestinal tract in three different (70, 80, 90% aqueous methanol) extracts concentrations. Number of Pteridophytic species having potential active compound and elaborative future prospects have been determined of immense economic value for the benefit of human society.

Perspectives:

1. Biodiversity in pteridophytes

The pteridophytes which dominated the earth during carboniferous are survived today by about 12,000 species comprising 305 genera. Amongst of which most numerous are the homosporous ferns comprised of approximately 11,500 species, where as rest 500 as fern-allies known globally. In India the Pteridophytes have been found to grow in almost all climatic zones under different habitats and represented by approximately 1200 species falling under 191 genera. In addition to species composition the Pteridophytes are very diverse in their habitat as well as occupancy. Accordingly, they have been categorized aquatic (*Azolla* sp., *Marsilea* sp., and *Salvinia* sp.), terrestrial (*Cyathea* sp., *Angiopteris* sp., *Pteris* sp., *Polystichum* sp., *Athyrium* sp., *Lycopodium* sp., *Diplazium* sp.), *epiphytic* (*Oleandra* sp., *Vittaria* sp., *Drynaria* sp., *Microsorium* sp.). However, most of the species of *Adianum*, *Psilotum*, *Cheilanthes* preferencialy grow on rocks, where as few others like

Actiniopteris, Woodsia and Onychium survive under extreme dry conditions. Very few are also known to grow in mangrove forests *viz*. *Acrostichum speciosum*. Amongst these Pteridophytes, the species of *Cyathea* commonly known as "tree fern" standing at a status of threatened category grow in tropical humid forests of the country. Being one of the twelve mega biodiversity countries of the world, India portraits three hotspots across its territory. The north east regions of the country comprised of seven provinces are a major component of the Eastern Himalayas which is richest in the Pteridophytic wealth. About 845 taxa belonging to 179 genera are known from these regions followed by the species composition of south India (Eastern and Western Ghats) from where approximately 345 taxa under 110 genera are known so far. In addition to above phytogeographical regions, the Western Himalayas of the North India stand at the third position exhibiting 340 taxa belonging to 100 genera. This trend of diversity and species composition has enforced the Indian subcontinent to be very distinct in respect of Pteridophytes. Therefore, about 17% of the total species known from the country are at endemic status which needs urgent attention for their conservation.

Medicine and pteridophytes:

The Pteridophytes are long known for their medicinal and therapeutical utility. In ancient period these plants were prescribed as herbal extract for the cure of several diseases. Theophrastus (327-287 BC) and Dioscorides (50 AD) listed many Pteridophytes as a potential herbal formulation to cure more deadly disorders. However, Shushruta and Charak in their monumental contribution on the medicinal attributes of ferns have enormously mentioned the utility of *Marsilea minuta*, *Adiantum capillus-veneris* etc. Few of the prescriptions were based on the doctrine of signature where plant of particular shape was recommended for the cure of certain organs resembling to it. First historical effort was made by Caius in 1935 to describe the medicinal uses of ferns in India, therefore get recognized as the first man to take this very initiative kind of investigations. Recently, enormous efforts have been made to determine the potentiality of Pterido-phytes in relation to their chemical composition and other aspects. These plants are distinct in having glycosides, flavonoids, terpenoids, alkaloids and many primary as well as secondary metabolites which are used for preparation of expectorant. Formulations of these plants are also advised as supplement of aphrodisiac, appetizer, stimulants; however, certain species are used for the ailment of diuretic, ulcer as well as stomachic. Few of the Pteridophytic species are historically in practice in the homeopathy as well as ayurvedic system of medicines. The *Selaginella bryopteris*, *Lycopodium clavatum* are well known Pteridophytes for the homeopathic system of medicine, wherein the *Selaginella* is prescribed for the cure of neurological disorder and heat stroke effects. Similarly, the *Lycopodium clavatum* is also recommended to the patients of splinted bones. The *Helminthostachys zeylinica* commonly known as 'Kamraj' is well known herbal ayurvedic formulation to enhance the sexual efficiency and as a source of stimulant and aphrodisiac. Few of the Pteridophyte species have been screened out chemically and numbers of active novel chemical compounds are validated. The marsiline isolated from *Marsilea minuta* has immense utility and is used in psychopathy, diarrhea, cough, skin diseases, dyspepsia fever and insomnia. Many other fern species have been extensively explored and determined to exhibit great economic value. The *Pteris vittata* commonly called "Braken fern" has also shown antimicrobial activities against number of gastro-intestinal bacterial strains. Thus, pteridophytes having tremendous importance and vast medicinal scope would prove itself as the biological resource for the upliftment of human society.

Fertilizer and pteridophytes :

The increase turnover of agricultural products was totally dependent on the fertilizers based on chemical origin. In spite of enhancing the rate of agricultural productivity, simultaneously these chemical fertilizers have devastating impact on the soil fertility. Thus, it has been an implicit need to look for an alternative fertilizer of biological origin. Traditionally, the cow dung and litter humus were supplemented to enhance the soil fertility. A little attention was paid towards Pteridophytes plants

wherein number of the species exhibit endophytic cyanobacteria which are rigorously involved in the nitrogen fixation. The cultivation of Pteridophytes species *viz. Azolla, Salvinia* and *Marsilea* in the paddy field has enhanced the agricultural productivity twice. In few countries the mulching of soil with these Pteridophytes along with few more are in common practices. Thus, Pteridophytes have an efficient trait of nitrogen fixation which directly or indirectly (developing transgenic) can be utilized as a resource biofertilizer.

Environmental management and pteridophytes:

The alarming rate of industrialization and urbanization has led the over emission of suspended particulate matter, metals and metalloids in the ecosystem of air, water and soil. These pollutants have toxic effect in living organisms at different biomagnifications level in water, soil and air. The bioaccumulation is a wonderful and cost effective technique to mitigate the impact of these toxicants. The plants particularly Pteridophytes are best known bioaccumulator of many metals and metalloids. *Pteris vittata, Marsilea minuta, Equisetum debile, Salvinia molesta, Azolla pinnata* has been experimentally determined as a hyper-accumulator of carcinogenic heavy metals *viz*. arsenic, cadmium, mercury, copper and chromium respectively. The arsenic has been major problem in the area of high water fed and paddy field practices mainly in West Bengal in India. Thus, these peculiar physiological properties of *Pteris vittata* can be utilized for the management of environmental related problems.

Food, fodder and pteridophytes :

The remotely residing people in the regions of tropical forests across the globe depends for their food and fodder on the plant resources available with them. The lower plants particular pteridophytes as well as bryophytes are the major component of the plant resources in such regions. The tribes uses the newly emerging foliar buds, crosiers, stripes and rhizomes of many fern species *viz. Diplazium esculantum, Angiopteris evecta, Nephrolepis cordifolia, Botrychium lanuginosum, Blechnum orientale, Cyathea spinulosa, Marsilea minuta* and *Pteridium aequilinum* as dietary supplements. Few of the species of pteridophytes *viz. Diplazium esculantum, Microlepia speluncae, Asplenium* sp., *Acrostichum aureum* with straminous stripes and peculiar foliar compositions are used as cattle fodder in the Asiatic and American countries. However, the dried pteridophytic plants are sprayed in the cattle shed as supplementary fodders. These sprayed plants also protect the animals from extreme cold acting as absorbent of urinal excreta playing a pivotal role in the animal husbandry practices.

Pteridophytes in industrial implications :

The poverty alleviation in the developing countries like India is coherent to the multifarious industrial setup. The bio-resource based industrial setup has been proving itself as an emerging field of economy development. The pteridophytes (*Nephrolepis cordifolia, Nephrolepis exaltata, Nephrolepis tuberosa*, *Adiantum incisum, Cyrtomium falcatum*) with their attractive foliar are enormously used during the ceremonial events as beautifying and decorative assets for their aesthetic appeal. Few of these species are used in the bouquet to extend the love in broad sense. The pteridophytes comprised of many relic species of the carboniferous periods are of immense importance in tracing the evolutionary trends in plants. However, many relic and recently evolved species are becoming rare and confined to fernery and nurseries with their high importance and increasing costs. In this way the industrial approaches of developing the fernery and nurseries can be an asset to meet out the requirement of fern lovers and enriching the economic inequities.

Genetic resources and pteridophytes :

Adaptation to diverse habitats has indulged the pteridophytes to exhibit wondering genetic traits. Many of the taxa adapted to cold, desiccation and rains have been very peculiar to synthesize the proteins of specific composition. These specific protein have enabled many pteridophytes *viz. Selaginella bryopteris, Cheilanthes farinosa* to tolerate the extreme desiccation, whereas, *Azolla* sp., *Salvinia* sp., are known to tolerate rain fed. These plants having such potentiality can be utilized as the genetic resource for executing various research related

activities and development of transgenic plants of high economic value.

Integral role of Pteridophytes in economy upliftment :

Pteridophytes having aesthetic appeal and one of the potential beautifying assets are recently in practice for decorative purposes. The ferns market has reached in million dollars involving many people of outreach regions globally playing a pivotal role in alleviating poverties. The medicinal application of these plants particularly in homeopathy and ayurvedic system of medicines are making billion dollars turn over globally. The raw materials of these medicines are excessively collected from the forests by tribes. But, the enforcement of the CBD (Convention on Biological Diversity) legislation has defined certain criterion for the utilization of biological diversity. Therefore, it has become prime necessity to sustainably utilize our bio-resources and equitably share its benefit. Thus, to meet out their requirement in the market, the enormous setup of fernery and nursery of these plants at small or large scale may help to uplift the economy of common people.

Conclusion :

The Pteridophytes having immense potentiality can be exploited for the development of many allopathic medicines of certain deadly and epidemic diseases. Few long known taxa used in homeopathic and ayurvedic system of medicines are to be produced at large scale involving the common or tribal people to meet out its requirement globally. As it is well known that the herbal medicines do not have any side effect, thus, these plants can be prescribed as herbal formulations to cure numerous diseases letting tremendous scope of economic earn. Though, uses of Pteridophytes in medicines are reported by tribe people, but it requires proper screening, testing, characterization and validation of exact compounds having their theraupeitical values. Secondly, the aesthetic ferns in demand of international markets are to be cultivated for cottage as well as large scale industrial setup engaging tribes to maintain their better livelihood.

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