REVIEW ARTICLE

Insight into Endophytic fungi in medicinal plants – A Review

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ABSTRACT

Fungi are group of organisms having a great biodiversity. They are the second largest group after insects and key component of tropical ecosystems throughout the world. Endophytes are group of microorganisms that resides asymptomatically inside the living plant tissues. Endophytic fungi are unexplored group of organism that has enormous potentials for new pharmaceutical substances. Medicinal plants and their endophytes are important resources for discovery of natural products. Plant endophytic fungi have been recognized as an important and novel resource of natural bioactive products with potential application in agriculture, medicine and food industry.

Key words: Endophytes, Medicinal plants, bioactive compounds

INTRODUCTION

Endophytes are microorganisms that inhabit plant hosts for all or part of their life cycle. They protect their host from infectious agents and adverse conditions. Thus endophytes play an important role in physiological and ecological role in their host life. The distribution of endophytic mycoflora differs with the host. It is found out that Endophytes can be transmitted from one generation to the next through the tissue of the host seed or vegetative propagules. (Carroll, 1988). Endophytic fungi were isolated from leaves of the weed Parthenium hysterophorus in order to establish whether the endophytes were the same fungi as had previously been recorded on scenescent or diseased leaf tissues. Seven surface sterilization methods were used. *Alternaria zinniae, A. helianthi, Cylindrocarpon* sp., *Curvularia brachyspora, Fusarium* sp., *Nigrospora oryzae, Penicillium funiculosum and Periconia* sp. were isolated The methods used to isolate endophytes may represent a tool for the identification of biological control agents of weeds (Romero 2001). Grass endophytes occur as non-sporulating , systemic infectious and are transmitted vertically from maternal plant to offspring through seeds (Clay ,1990). Bacon and White (2000) give an inclusive and widely accepted definition of endophytes—"microbes that colonize living, internal tissues of plants without causing any immediate, overt negative effects".

The mutual relationship benefits the endophytic fungi through provision supply of energy, nutrients, shelter as well as protection from environmental stress. On the other hand fungal endophytes indirectly benefit plant growth by producing special substances mainly secondary metabolites and enzymes, which are responsible for the adaptation of plants to abiotic stresses such as light, drought, and biotic stresses such as herbivore, insect and nematode attack or invading pathogens. Some endophytic fungi have developed bioactive compounds as those originated from the host plants. Endophytes may produce a plethora of bioactive metabolites that may be involved in the host-endophyte relationship and may serve as potential sources of novel natural products for exploitation in medicine, agriculture and industry (Bacon and White 2000).

Fungal endophytes act as potential producers of novel and biologically active compounds. Many valuable bioactive compounds with antimicrobial, insecticidal, cytotoxic and anticancer activities have been successfully discovered from the endophytic fungi. These bioactive compounds could be classified as alkaloids, terpenoids, steroids, quinines, lignans, phenols and lactones (Xu L, Zhou L, 2008).

Plant selection

It is important to understand the methods and rationale used to provide the best opportunities to isolate novel endophytic microorganisms as well as ones making novel bioactive products. A specific rationale for the collection of each plant for endophyte isolation and natural-product discovery is used. Strobel and Daisy (2003) discussed the following methods of selection:

(i) Plants from unique environmental settings, especially those with an unusual biology, and possessing novel strategies for survival are seriously considered for study.

(ii) Plants that have an ethnobotanical history (use by indigenous peoples) that are related to the specific uses or applications of interest are selected for study. These plants are chosen either by direct contact with local peoples or via local literature. Ultimately, it may be learned that the healing powers of the botanical source, in fact, may have nothing to do with the natural products of the plant, but of the endophyte (inhabiting the plant).

(iii) Plants that are endemic, that have an unusual longevity, or that have occupied a certain ancient land mass, such as Gonwanaland, are also more likely to lodge endophytes with active natural products than other plants.

(iv) Plants growing in areas of great biodiversity also have the prospect of housing endophytes with great biodiversity. Just as plants from a distinct environmental setting are a promising source of novel endophytes and their compounds, so too are plants with an unconventional biology.

Endophytic fungi from medicinal plants

In recent years, it is seen that the isolation of new compounds from medicinal plants has become a fascinating area of research. Plants with ethno-pharmaceutical importance are being exploited because of their healing properties. However, a large scale harvesting of medicinal plants has already become a major threat to biodiversity. As an alternative, microbes which live inside such plants (endophytes) may offer tremendous potential source of novel medicinal compounds. (Endophytes infected plants often grow faster than non-infected plants) which could be utilized for potential applications. It has been estimated that there may be 1.5 million fungal species, while only about 100,000 species are presently known (Hawksworth 2004).

Western Ghats of India is thus a rich source of biodiversity of micro-organisms, which plays a vital role during the growth of fungi. Western Ghats of India are known to be an active hotspot region with enormous biodiversity wealth.

The studies of endophytic fungi and medicinal plants with a emphasis on the factors that possibly influence the population structure and distribution of endophytic fungi. It also provides new insights into drug discovery and clinical utility which can be further improved by investigating endophytes further as these have the potential of playing a key front line role in the treatment of various diseases.

Isolation of Endophytes

Endophytes can be isolated from various plant parts such as seeds, leaves and stems. The collected plants for studying endophytic communities should look apparently healthy and disease free plant, i.e. they do not display any visual symptoms of diseases, in order

to minimize the presence of plant pathogenic and saprobic species, and to prevent the isolation of localized pathogenic endophytic microorganisms.

The most important step for the isolation of endophytic fungi that reside in plant tissues is surface sterilization and the plant parts under investigation should be cut into small pieces to facilitate sterilization and isolation processes. (Strobel 2003)

Petrini (1991) isolated Endophytic fungi from medicinal plants more likely exhibit pharmaceutical potentials. Plant endophytic fungi have been found in each plant species examined and it is estimated that there are over one million fungal endophytes existed in the nature. The secondary metabolites produced by endophytes associated with medicinal plants can be exploited for curing diseases.

Rajagopal and Suryanaryanan(2000) isolated five endophyes from the leaves of Neem. Of these, four were sterile forms and one was *Fusarium avenaceum*. The result showed that colonization frequency percentage of endophytes was significantly higher in the monsoon season (49.6%) than during the dry seasons (24.3%).

Suryanarayanan and Rajagopal (2000) isolated 963 isolates belonging to 36 fungal species from the bark tissues of ten tropical forest trees. Of these, four were Ascomycetes, one belonged to Coelomycetes and eleven were Hyphomycetes rests were sterile mycelia forms.

Raviraja (2005) reported on the fungal endophytes in five medicinal plant species from Kudremukh Range Western Ghats of India. He isolated 18 species of endophytic fungi from bark, stem and leaf segments of five medicinal plant species growing within Kudremukh rang. pe in the Western Ghats of India. The dominant species were *Curvularia clavata , C. lunata*, *Callescens and F. oxysporum*. The higest species richness as well as frequency of colonization of endophytic fungi was found in the leaf segments rather than the stem and bark segments of the host plant species. The greatest number of endophytic fungal species were found within Callicarpa tomentosa (11 species), whereas *Lobelia nicotinifolia* harbored the lowest number of fungal endophytes (5 species). The study provides evidence the fungal endophytes are host and tissue specific.

Tejesvi et.al. (2006) isolated fungal endophytes from inner bark segments of , ethnopharmaceutically important medicinal tree species namely *Terminalia arjuna Crataeva magna, Azadirachta indica , Holarrhena antidysentrica, Terminalia chebula, Butea monosperma* growing in different regions of Southern India and species of *Fusarium, Pestalotiopsis*, *Myrothecium, Trichoswema, Verticillium and Chaetomium* were isolated.

Gangadevi and Muthumary (2007) studied on endophytic fungal diversity in young, old and senescent leaves of *Ocimum basilicum L*. a medicinal plant. Not much is known on the temporal and spatial variation of fungal endophytes inhabiting the foliage of medicinally important plants. This study provides the first report on diversity of endophytic fungi of medicinal plants from Chennai city Southern India. Added to it one of the isolates *Phyllosticta sp.* was found to produce taxol in artificial culture media . the endophytic fungus is thus expected to artificial culture media. The endophytic fungus is thus expected to be a potential source of natural bioactive agent.

Mohanta et al., (2007) studied the antimicrobial potentials as endophytic fungi inhabiting three Ethno-medicinal plants of Similipal Biosphere Reserve India. Nearly 60 fungal endophytes belonging to genera were isolated out of which 31 endophytes (51.66%) were obtained as filamentous forms and 29 of them (48.33%) as yeast colonies. Species of *Curvularia, Fusarium*, *Alternaria* and *Penicillium* were isolated as dominant and host specific endophytes. Among the potent strains of about 13 isolates, 19.3% displayed both antibacterial activity against all the test pathogens. The study reinforced the assumption that endophytes of ethnomedicinal plants could be a promising source of anti- microbial substances.

Devi (2014) studied the antioxidant activity of the endophytic fungus *Penicillium* sp. isolated from medicinal plant *Centella asiatica* was evaluated by its ability to scavenge DPPH (1,1- diphenyl -2- picryl-hydrazyl) free radicals. Bioactive metabolites present in the ethyl acetate extract from the endophytic fungus *Penicillium sp*. were analysed by using GC-MS. The metabolites were investigated for cytotoxic activity.

Karunai Selvi (2014) isolated fifty one fungal endophytes belonging to twenty one genera were isolated from medicinal plants in Virudhunagar

District. The crude metabolite of endophytic fungus *Cladosporium sp*. displayed a significant antimicrobial activity against all test pathogens. Phytochemical analysis of the ethyl acetate solvent extract revealed the presence of saponins, phenolic compounds, anthraquinones, steroids, cardiac glycosides and tannins in *Alternaria alternate and Cladosporium* sp. The extract of *Acyranthus aspera* was effective against all test organisms except *Bacillus cereus, B. subtilis and Proteus sp.* Endophytes can reduce the growth of the harmful bacteria in plants by different mode of action.

Shiva (2015), reported Endophytic fungi isolated from four different populations of *Urginea indica*. The plants were collected from 4 different localities which includes Seethampundi (Tamil Nadu), Yediyur (Karnataka), Allepy (Kerala) and Udupi (Karnataka).It is an important medicinal plant found distributed in India, Africa, andMediterrean regions and widely used for the treatment of Edema, Dropsy, Gout, Rheumatic pain , in trating cancer and as cardiac stimulant. Plant portions viz., pseudostem, outersheath, inner leaf sheath and root parts were inoculated on potato dextrose agar medium amended with chloromphenico The presence of 12 endophytic fungi belonging to Hyphomycetes and Coelomycetes were identified from *U. indica* by means of morphological and cultural features . Sterile forms were common to the host. A total of 6 fungal species viz., *Acremonium, Aspergillus niger, Cladosporium*, *Curvularia lunata, C. brachyspora, Penicillium* species belonging to the class Coelomycetes and some sterile forms were recorded. The present study provided a clue that the existence of endophytic fungi in *U. indica* and it can be of great importance if further studies conducted on to elucidate their role in the host plant and for bio-prospecting.

The most valuable application is to utilize the advantages of endophytic fungi that can promote the accumulation of secondary metabolites originally produced by plants. Through such an application, we can enhance the synthesis and accumulation of bioactive compounds by adding particular endophytic fungi to the plants. This application may open a complete new dimension to produce natural medicines in an extremely effective manner, given that the relationship between endophytic fungi and their host medicinal plants is completely understood.

CONCLUSION

This review represents data on microbial diversity of Western Ghats of India, with an emphasis on exploiting them for potential applications for socio-economic development of India. A variety of relationships can coexist between endophytes and their host plants, ranging from mutualism or symbiosis to antagonism or slightly pathogenic (Schulz and Boyle 2005, Arnold 2007). The host-endophyte relationships can be described in terms of host-specificity, hostrecurrence, host-selectivity, or host preference (Zhou and Hyde 2001, Cohen 2006). As the endophytic fungi are a good source for bioactive compounds and a great demand arises for new drugs, there arises a need to exploit the endophytic fungi associated with medicinal plants. Innovative and effective approaches should be made to strengthen fledgling participation of various research groups and civil societies to catalyze exploitation and conservation of Western Ghats biodiversity.

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