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Potential of Endophytic Medicinal Plants Found in Uttarakhand

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ABSTRACT

Uttarakhand is the abundant resource of plants having medicinal properties and conventional medical information, often considered as the Herbal State. Various information is dispersed in various ways about medicinal plants in Uttarakhand. Medicinal plants are a large community of fungal endophytes, which are recorded in traditional indigenous preparations. Higher height medical herbs have the ethnopharmacological niches amongst these geologically varied medical fauna. Higher height medical fauna were utilized in a way that they are excessively endangered due to their enormous bioactive potential. The study was conducted for the sampling of many endophyte literature studies to enable a better understanding of the process by which endophytes perform so that the current situation in microbial information can be thoroughly assessed. The higher altitude medicinal plants can also be investigated and bioactivity tested for the endophytic fungal diversity. The study was conducted for the view of biology for aiding pharmaceutical procedures of fungi endophyte from therapeutic products of mountainous areas of Uttarakhand. The current study can aid further studies for the development of effective medicines.

Keywords: Endophytes, Fungal, Medicinal, Plants, Uttarakhand, Growth, Research

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INTRODUCTION

Himalayas are famous for the world's wealthiest location of medicinal commodities. This provides immense potential in different areas of advanced biological fields linked to processes to promote sustainable existence. Around 8644 species of plants belonging to 1748 families in the Indian Himalayas region. Plants varieties are documented as pharmaceutical fauna and more than 1800 m altitudinal ranges has been recorded. Out of the Himalayan countryside, often identified as Dev Bhoomi, Uttarakhand is full of glorious natural wonders, a wealth of herbs and traditional medicines. In ancient times, the main reservoirs of medicine and highly nutritious supplies throughout the world have been medicinal plants and materials. Medicinal plants are one of the most significant ingredients and are well established for their effectiveness in the treatment of diverse diseases in the Himalayan forests. Many ancient Indian scriptures show that Himalayan plants have abundant advantages [1].

Even today, several areas in sub-urban and rural India and also the entire globe have specifically utilized multiple plant components such as the roots, stems, and leaves, etc., because, unlike allopathic medicine, there are no side-effects symptoms. Eighty percent of the whole world also depends on conventional drugs as stated by the World Health Organization (WHO) [2]. Plants are a common resource of lignans, alkaloid, calcareous, flavonoid, phenol, alkanes, alkanes, polyketides, basic aromatics, peptides and medicinal steroids. Because of these immense therapeutic properties, in the present age of drug detection, plants are exclusively used to find medicinal molecules. In developing countries, including India,

phytomedicines play a vital role in healthcare monitoring systems. In the last few years, the global biotechnology industry has received strong exposure and interest from medical plants [3].

New and beneficial substances in all areas of human health are becoming increasingly necessary to provide assistance and relief. The development of "drug" resistances is likely for both human pathogens and fungal phytopathogens. The efficacy of older antibiotic forms will significantly decrease. Furthermore, several synthetic agents were and now are aimed at withdrawal from the market due to the protection and environmental issues [4]. The elimination of these agents means that novel approaches of regulating agricultural pest and pathogen are required. Ascomycetes and Deuteromycetes correspond to fungal endophytes. Besides, few other members of the basidiomycete's family are endophytes.

Endophytes with a special biotope with an estimated world population of up to 1 million organisms are the ideal alternative in the analysis of natural products to prevent reproduction in order not only to solve plant diseases but also human and animals' issues. Endophytes are chemical plant synthesizers; they are a microbial method of selection for the production of lowly toxic pharmacological compounds and published the listing of the accepted agents from 1981 to 2006 from which the highest numbers are generated by endophytes. Endophytes are chemical plant synthesizers.

Many proofs exist of the possible alternative pathways to development for new medicines for bioactive compounds developed by endophytes. The endophytic funguses were identified as the sustainable complementary sources of taxol. Natural materials are suited to a particular nature purpose. The quest for new secondary metabolites should therefore focus on new biotype species [5]. Endophytic fungi live in a not well-studied biotype. Endo-based micro-organisms represent an important reservoir of high potentially effective uses in livestock, medicine and the food industry of novel bioactive secondary metabolites like antibacterial, anti-insect, anticarcinogenic, anti-diabetic and immune as substantial substances. The most commonly known bioactive ingredients are isocoumarins, phenols, hormones, phenol prostanoids, alkaloids, quinones, flavonoids and lignans. Global drug-resistant bacteria and fungi-induced health issues are growing.

There's a lot of conventional knowledge about Uttarakhand medicinal plants in text, for example, taxonomy, generic names, locality, medicinal usage and partial use. Furthermore, genomics was not carefully recorded nor digitized regarding these invaluable medication plants. Just recently, a great deal was done to improve datasets and tools in this field. Amusingly, a large number of public collections for medicinal herbs and their extracted phytochemicals have been created over the last 4-5 years [1].

Distribution of endophytes in plants

The intercellular space and vascular tissue typically include endophytes within the plants. Most experiments have been conducted on such foods that have been chosen. Colonization of endophytes influences the ability of plant components to display their lives. The analysis of Castillo et al. [6] and Bezerra et al. [7] showed this compartmentalization, also in the same soil as the neighbouring floor compartment, when the same isolates were not obtained. The analysis revealed that only Pseudomonas sp. was present in any plant region, while Arthrobacter and Bacillus also were present in roots and stems. Pseudomonas was then confirmed to be the most prevalent genus from the rhizosphere of the plant. The rhizome role of organic acids and aromatic products such as phenols resulted in this. Owing to its capacity to breakdown organic molecules as energy sources, the observed excess of Pseudomonas sp. may be a consequence [7].

Few studies have suggested that fewer isolates have been compartmentalized. The research, for example, has been conducted throughout every portion of the plant to investigate pathogens' occurrences in Burkholderia, crossbreed aspen, Methylo-bacterium, as well as several other unexposed bacteria. Pseudomonas, Arthrobacter and more micro-bacteriaceae are present in the roots and leaves whilst airborne associated bacteria are insulated from stem and leaves from *Microbacteriaceae*, *Sphingomones*, *Aerolata* and *Sphingomonas auranica*. In this analysis, the larger amount of Sphingomonas on the plant's surface describes the organism's life situation in that area, which establishes its ability to tolerate UV rays. Others have identified such microbes of plants that are frequently pigmented to improve their position on floor surfaces. Distinctions in the spread of isolated endophytes in the plant might just have emerged as a result of causes that may involve both the growth media and variations in the physiology of plants. Nevertheless, more work should be undertaken to genuinely determine the reasons [8]. The extent of the colonization of endophytic fungi in trees has been recorded in dispute. Whereas several reports have shown the maximum colony in the stem, some have focused on the leaves. Petrini's [9] research, nevertheless, spread the misunderstanding that specific tissues and organs of plants might constitute distinct microhabitats. Thus, the overall intensity of colonization of endophytes can be determined based on the host-plant age, related crop, biodiversity growth and environmental exposures. In other words, the presence of endophytes is affected both by the changes of seasonal, ecological and host tissue.

Endophyte-Plant symbiotic relationship

While contaminants, predominantly bio-toxic to micro-organisms and plant, many plant which grow in the contaminated soil tend to host many bacteria which display their ability to degrade the pollutant. Nevertheless, endophytes in most cases display their symbiotic commitments to their host, through the different physiological connections among them and

plant species: The plant provides endophyte with nutrients, whereas, as a result of their actions, microbes produce active metabolites. The actively release metabolites allow the plants to have more supply of nutrients in their root growth.

It also supports the protection of plants from drying, bugs and parasites. This symbiotic behaviour allows endophytes to encourage the growth of host plants and the provision of resistance mechanisms. The symbiotic relationship of endophytes and plants has recorded a widespread occurrence. However, the study says the relationship is shifting from reciprocal to a parasite. However, a modification in any given gene can modify the whole process of the endophyte. *E. festucae* has shown this: A sparkling fungus contained in intercellular spaces to spread, that has been confirmed to not only promotes growth of the plants but also to advance the plants' resistance to pollution. This study showed the lack of apical superiority that contributes to the plant's demise when an enzyme plasmid was injected into the endophyte code region. This suggests that contamination in multiple hosts by the same endophytes leads to various behaviours [10].

Xu et al. [11] research demonstrated the phenomena by saying that *Colletotrichum magna* can induce a certain crop disease once inoculated in cucurbite plants. But it is asymptomatic when in non-cucurbite plants. The relationship between endophytes and plants may be either parasitism or mutualism. Symbiosis contributes to differences in its impacts on biocontrol, stimulation of growth as well as bio-rehabilitation.

Biological control of endophytes

Fungi became the first endophytic cells to be recorded, as per research records. Therefore, fungi are among the endophytes mostly established. These species have been found to preserve and support plantations for development. Although endophytes are well recognized to be taxonomically diverse, they largely depend on environmental or functional grades in their fungal classifications [12].

The vast losses have been caused by agricultural activities and their goods have placed plagues and diseases under threat to the growth of agriculture. Chemical pesticides were identified as a response to the threat of pests and fungi, but they have contributed to the deterioration of human health and the climate. Pesticide effects on soil and water emboldening have had a significant impact on the environment's ecological status. Few bacterial endophytes are capable of reducing the adverse effects of certain pests and their infections. In order to monitor and decrease the use of a chemical in farming, it has, for instance, been recorded as alternate measures to manage the impact of pests. As per the report by Elmi et al. [13], 35 days in high fescue since contamination with fungal endophytes had been degrading the number of root-nuclear enteropathic microbes (nematodes) without impacting the root's dry weight.

Many reports have identified consequences on the prevention of infections by plant-colonized endophytic bacteria. This increases plant microbial tolerance by colonizing entomopathogenic microbes after inoculation. Some other endophytic bacteria are involved in plant-pathogen protection. Since the endophytes have a specific symbiotic lifestyle depending on the species concerned, parasitic or/and reciprocal interactions between both the hosts are the two potential ways of acting endophytes, as stated. Other modes derive their string from these two potential modes of behaviour. The relationship between endophytes and plants has therefore been defined as a continuum (Figure 1) [14].

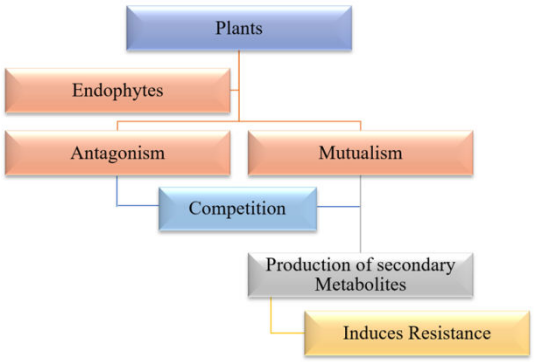

Figure 1. Depiction of plants-endophytes interactions and method of action.

For instance, in parasitism, the egg of banana weevil is stated to be parasitized in the laboratories. This was the mode of parasite endophytes in insect or disease causal attacks. In competition, the competitors for nutrition as well as that of contamination locations are driving endophytes in specific. For *e.g.,* pseudomonas sp. produces iron chelate siderophores, absolving the important nutrient of microbes. This suggests the organism is vying in the system of its host for iron nutrient centers. The secondary metabolite generation of endophytes is undeniably the main mechanism of action. In endophytes, there are so many secondary metabolites found. Tomatoes have shown oxysporum extracted endophytes to trigger the youthful death of nematodes by decreasing hatchability rates. Pseudomonas sp. and actinobacteria are great contenders to produce antibacterial, antifungal and antiviral metabolites stocks. Resistance is triggered by the activation of various biotic and abiotic inducers in interaction with the plant defensive measure. This normally leads to less exposure to a plague or pathogens.

The total figure of endophytic organisms in a specimen was still overlooked prior to the start of molecule technique for analysis of fungus in endophytic study. This is because endophytes must be compelled by this method: The fungi that do not develop well are generally not insulated in the chosen medium. However, the amount of fungus species described per hosts' plants species has improved significantly with the advent of DNA sequencing. That's because, in laboratory cultures, an essential percentage of isolated strains should be sterile. The detection and differentiation of sterile

cultures were supported by genotypical identification approaches. The implementation of new biotechnological techniques thus contributed to the research and bio-control operations of endophytes [15].

Plant development with the help endophyte

The capacity of endophyte to promote growth of the plant diverges from the capacity of biocontrol strain since they do not oppose pathogens' activities but rather require an improvement in nutrient cycling production. Endophyte biological activities are defined to strengthen phytohormone production, which performs a substantial part in the extension of the roots and encouragement of plant growth. Several metabolites of endophytes have been involved in this systemic activity that includes indole acetonitrile, gibberellin and cytokinine but are all active in promoting plant development.

The consequences of endophytes on plant life are other advantageous: osmotic equilibrium abjection, stomatal control, root morphology change, improved mineral absorption and metabolism alteration. It is literary that some special hormones have been isolated by medicinal plant endophytic fungi and by incorporating these hormones into an orchid plant, improves plant growth. Endophytes were also assessed for improving their germination capacities and promising conclusions drawn from a study on the reduction of disease symptoms resulting from such activities. Actually, woodland restoration and phytoremediation practices are used to promote the development and effect of plants. Endophytes are reported to stimulate adaptations and growth of the plant through their means of fostering growth [16]. They do so by utilizing various mechanisms:

- By phosphate solubility improves the host's environmental stress;
- Improve the production of growth hormones;
- Encourage the synthesis of siderophore;
- Increases the production of biological constituents of plants, such as vitamins and minerals;
- Support osmotic regulations;
- Stomatal adjustments;
- Encourage the use of mineral;
- Supports the processing of minerals.
- Uses of endophytes

Endophytes for instance as de-composing agents of the aged salt ponds plant are involved in some other use. Few other endophyte have shown the potential to improve osmoregulation of plants tissues, which can increase plant tolerance, for instance, to severe disease. Many of such strains of endophytye are used for marketing in turf grasslands to help withstand both biotic and abiotic environments. Few endophytes implicitly interact with pathogens to promote plant development and decrease activity. Endophytes can also be a biological instrument used in genetic experiments as a pool for the gene carrier and genetically engineering endophytes can be used to shield the host. Fahey showed the first effective proof of exogenous gene expression.

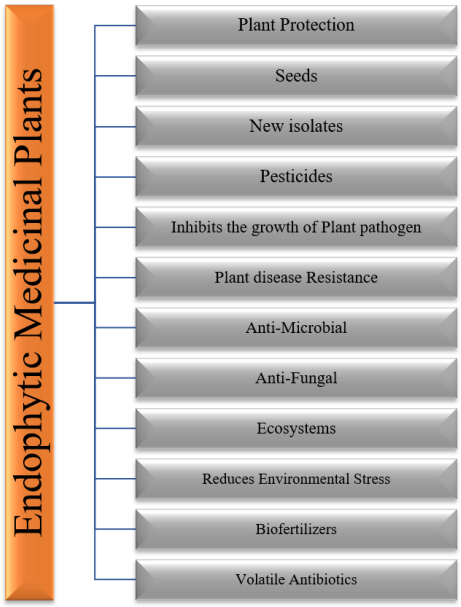

Figure 2. Various benefits of endophytes found in the medicinal plants.

Over the past couple of decades, the usage of endophytes throughout the plant remediation of different pollutants in the atmosphere has been given greater importance. Approximately four of these genetically engineered plasmids were used to phytoremedy toluene through the application of Ptom toluene destruction plasmid B. *cepacia* G4. The recombinant strain led to the major deterioration of toluene. Injection of pea plants (*Pisumativum*) by hereditarily engineered bacterial endophyte, which were genuinely able to decompose 2, 4-dichlorophenoxy acetic acid, also identified by Germaine et al. The findings indicate that plant injected with pseudomonas putida have a high degradation potential of the soil compound. In an alternative analysis, the use of engineered endophytes to increase the environmental clean-up of radioactive phytoremediation of metals was improved. This research shows the potential of the interaction between microbes and plants in the rehabilitation of contaminated sites and may be helpful in developing effective processes for the elimination of environmental contaminants. Consequently, these associations among plants and micro-organisms need more knowledge to be used on the ground [8]. Various benefits of endophytes are represented in Figure 2.

LITERATURE REVIEW

There seem to be no study interest concerning the resistances of endophytes by the organism and there can be no much further explanations behind them. One main reason can be attracted back by the complicated association amongst hosts and endophytes; whilst the other is because the biological mechanism of living and the condition of endophyte are virtually difficult for people to duplicate. But Xu et al. [11] said that such an interpretation may be based on the following points:

The plant promotion as well as the capability of endophytes to avoid pathogen/insects can be connected to the toxicant they synthesize in this step. The actions of certain pathogens are mostly inhibited by these toxicants. Therefore, endophytes are related to the toxicant they create and to the growth promotion and pathogen resistance potential.

Often, endophytes can also have the secondary metabolites that improve their host competition, which has been supported by literature, since they avoid some unfavorable conditions. Nevertheless, the literature demonstration of this proposition did not dampen the controversies on this particular subject.

Whilst literature has shown that pathogens are directly related to endophytes mechanism, other scientists also claim that it is indirectly connected with insect systems. For example, an insect gall inhibition provides endophyte hosts with resistance to the insect. This phenomenon has led to a lot of recent debates about the role of endophytes on the regulation of insects. Zabalgogeazcoa [17] studied in which the endophyte modes of activity and their associations with pathogen-plant were emphasized. The research showed that few endophytes are infection experts and others are generalists. Adame-Alvarez et al. [18] indicated nevertheless that in the case of disease facilitation resistance induction the number of endophytes in tissues affected the relationship of endophytes and pathogens, which may contribute to facilitation, increase the host's resistance adversely and cause no effects [19]. Figure 3 shows the endophytic biology leading study.

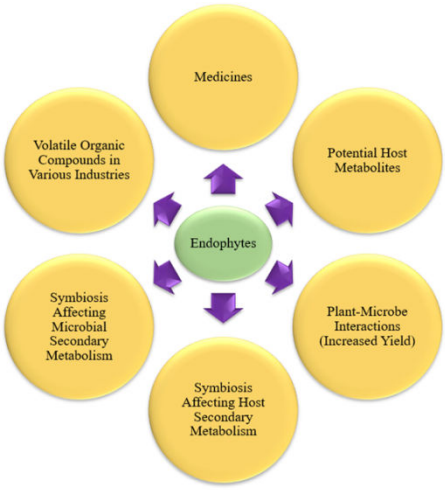

Figure 3. Study of endophytic biology leading to its symbiotic relationship with the plants.

T.S. Suryanarayanan et al. [20] conducted a study on 11 lichens species that grow on the bark of the tree named *Quercus leucotrichophora*. They conducted this study in four forests of Champawat region in the Uttarakhand. Researchers noticed that the *Xylaria spp*. is most common in the selected 11 lichens. In this study, researchers tested the endolithic *Xylaria* with the other three endolithic funguses that were extracted from the similar thallus. They initiated their research with the silica gel coated aluminum thin-layer chromatography after that they performed air drying and spewed with Chlorella fusca t cells gain, to more knowledge about the antialgal properties. After performing the spraying, they incubated the gels for three to five days without any light. With this research they concluded that there was no distinctly different trend of endolithic fungi occurrence about or locating the taxonomy of lichen, perhaps indicating the endolithic fungi generalist character.

Neha Kapoor et al. [21] conducted a study on *Ocimum basillicum*, *Syzygium aromaticum* and *Withania sominifera* that are found in high altitude regions. In their research, they stated that 14 fungal endophytes were extracted from the aforementioned *Ocimum basillicum*, *Syzygium aromaticum* and *Withania sominifera*. It was reported in their research that most of the fungal colonization was only in the two species (*Syzygium aromaticum* and *Withania sominifera*). They also recorded that enzymes like amylases, proteases, celluloses, etc. are found in most of the endophytes of *Ocimum basillicum* and a significant amount of aspaginases activity was recorded by the isolates of *Syzygium aromaticum* and *Withania sominifera*. Hence in their research, they concluded that the medicinal plants that are found in the high altitudes are consisting of a high amount of endophytes which holds the potential for curing many deadly diseases and hence they suggested the prevention of such species of plants.

Rinky Bisht et al. [22] conducted a study on the antibacterial and antagonistic activities of endophytic fungi that are found in the *Cupressus Torulosa* D. Don. The symptomless needle of the aforementioned plant was taken from the Garhwal region of Uttarakhand. They isolated five types of endophytes from these needles of *C. torulosa* D. Don. After evaluating five isolates they proceeded with only two isolates. They found that the two selected isolates showed strong antagonism properties towards fungal pathogens. And hence they concluded that the endophytye fungus obtained from the *C. Torulosa* D. Don can be of great importance and have significant potential in the future pharmaceutical industries.

CONCLUSION

Endophytic medicinal plant has represented a huge part in improvement of human health and are an inspiring role for new drug compounds. Endophytic fungi are poorly studied microorganisms, one of the best sources that can be used in different medicinal and industrial fields for bioactive and chemical new substances. Studies discussed above shows that this endophytic fungus has enormous potential for use as a potential source and a source of essential medicinal products in the field of pharmacology. It was found that certain plants produced the same natural compounds. The synthesis of bioactive compounds will then stimulate the new product development process through fungal endophytes isolated from plants. Although was also found that some of these plants are on the verge of extinction. Government policies

and restrictions should be implemented in states like Uttarakhand to prevent the extinction of such plants.

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