Editorial

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Endophytic Fungi as Emerging Bioresources for Bioactive Compounds for Sustainable Development

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Endophytic microbes dwell in the interior of plants during some period of their life cycles thus establishing mutualistic as well as symbiotic relationships. These microbiomes from uncommon bioresources and unexplored ecological niches have been regarded as promising tools for the search of new leads. Endophytic fungal communities have been receiving more attention from microbiologists due to their huge biodiversity and largely unexploited metabolic resources. Bioactive compounds from endophytic fungi have a great potential as antimicrobial, anti-cancer, antitumor, ant parasitic and ant diabetic agents. Further, the color and enzyme producing endophytes have application different industries. Thus, fungal endophytes in recent years have emerged as a promising alternate bioresources of secondary metabolites for sustainable development.

Plants host microbes in their internal tissues which reside asymptomatically and do not cause any noticeable symptoms of diseases and are called as the endophytic microbes. These endophytic microbiomes provide protection to their host against the stressful environment [1]. Among the endophytic microbes, endophytic fungal communities have been studied the most. Endophytic fungi are the repertoire of bioactive compounds those are chemically and structurally diverse and applicable for different applications for sustainability.

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Endophytic fungal communities are known to produce alkaloids, phenylpropanoids, polyketides and terpenes. Secondary metabolites exhibit a range of the biological activities such as antibacterial, antifungal, anticancer, antidiabetic, antiparasitics, antiviral, and immunosuppressants [2]. Secondary metabolites from endophytic fungal communities could be used to as biopesticides to control the diverse human and plant pathogens for sustainability [3, 4].

Over the past few decades, endophytic fungal communities from diverse groups of plant sources have been reported as valuable bioresources of bioactive compounds for diverse biological processes in agriculture, industry and medical sectors [5]. There are many reports on production of natural compounds as secondary metabolites from endophytic fungal communities [6]. Recently Zhou *et al*. [7] reported antimicrobial and cytotoxic potential of *Botryosphaeria fusispora, Fusarium verticillioides, Neopestalotiopsis protearum, Pestalotiopsis* sp. and *Phomopsis longicolla*. There are many reports on endophytic fungal communities from diverse host and their role for productions of bioactive compounds including pigments, enzymes, organic acids and secondary metabolites (Figure 1).

Endophytes have a major role in protection of their hosts against abiotic and biotic stresses. There are studies which support the fact that the presence of fungal endophytes influences plant growth, development and fitness. Fungal communities have been isolated from diverse sources and produced of various hydrolytic enzymes, different pigments and other secondary metabolites with diverse applications in agricultural and industrial sectors. The endophytic fungi provide immune system to host plant to defend against different phytopathogenic microorganisms [8]. De Silva *et al*. [9] reviewed the biocontrol potential of endophytic fungi

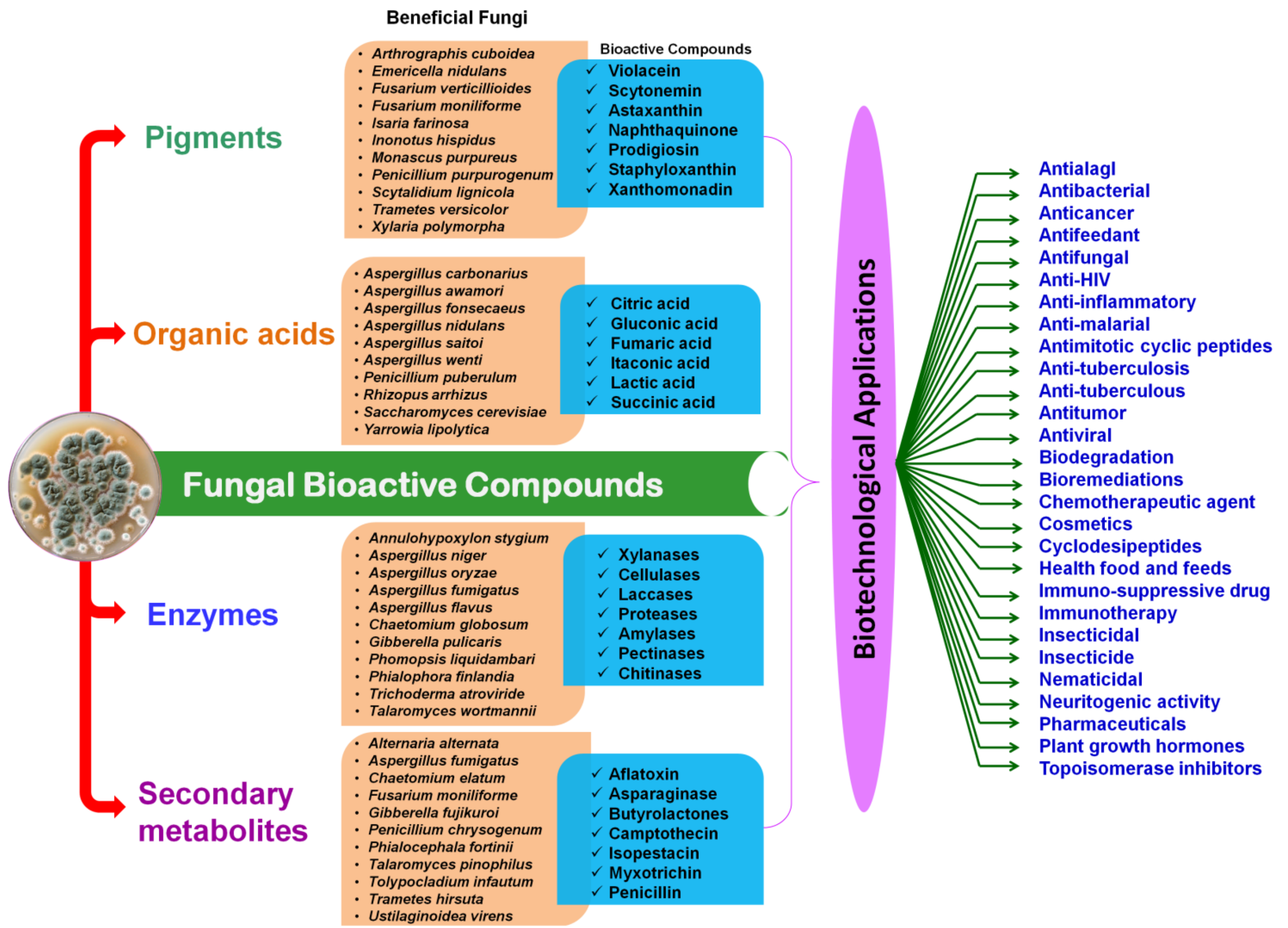

Figure 1. Biotechnological applications of fungal bioactive compounds from diverse fungal communities for sustainable development, Adapted with permission from Yadav *et al*. [10]

including the species of *Pestalotiopsis*, *Cladosporium*, *Colletotrichum*, *Fusarium*, and *Trichoderma* as an attractive tool for management of some plant diseases.

The research on microbial enzymes is growing due to ease of availability, cost effectiveness and eco-friendliness. Endophytic fungi produce several hydrolytic enzymes which find applications in food, dairy, textile and detergent industries [11]. Proteases along with other hydrolytic enzymes are utilized in fruits, food and milk processing. Protease production by endophytic fungi has been reported from diverse fungal communities e.g. *Alternaria*, *Bipolaris*, *Colletotrichum*, *Diaporthe*, *Lasiodiplodia*, *Marasmius*, *Penicillium*, *Phlebia*, *Phoma*, *Phyllosticta*, and *Schizophyllum* [12, 13]. Amylases find applications in liquefaction, manufacturing of maltose, oligosaccharides mixture, and in other biological processes [14]. Pectinases find applications in wine, food, paper, and waste paper recycling industries [15]. Pectinase production has been known in endophytic fungi [16, 17].

Fungal communities produced diverse group of pigments used as natural food colorant. The potential applications of fungal pigments in foodstuff and feedstuff are increasing day by day [18]. Endophytic fungi are an excellent bioresource among the pigment producers. A number of pigments have been identified and characterized form endophytic fungi [19]. Endophytic fungi are a splendid bioresources of novel bioactive compounds could be exploited for curing diseases. A huge number of novel bioactive compounds i.e. enzymes, pigments and secondary metabolites have been reported as antimicrobial, anticancer, and anti-inflammatory in agricultural and pharmaceutical sectors. The search for unexplored habitats for isolation and screening of the endophytic fungi is becoming a significant concern for the pharmaceutical and agricultural industries. Thus, endophytic fungal communities prove an amazing alternative of great potential agricultural sustainability, as well as food and pharmaceutical industries for sustainable development. The biology of the endophytic fungi, their association with the host plant, and their biotechnological potential could be further studied using molecular tools including genomics, proteomics, metabolomics, transcriptomics, high-throughput and next-generation sequencing and bioinformatics.

CONFLICTS OF INTEREST

Author declares that there are no conflicts of interest.

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