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An Insight into the Properties of Fungal Endophytes Derived from Lantana Camara

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Abstract

Lantana camara is a notorious, noxious and invasive weed having 650 varieties in over 60 countries. It is established and expanding in many regions of the world. There are different species of fungal endophytes residing in lantana which are having numerous properties also. The main fungal endophytes isolated from lantana are Helminthosporium sp and Fusarium oxysporum, Alternaria alternata and Aspergillus nidulans. These fungal endophytes are capable to produce certain bioactive compounds such as 1-docosanol, 1-octadecanol, all-trans- anhydrorhodovibrin, perillol, phytol, n-hepta-decanol-1, n-hexadecanoic acid. These bioactive compounds are efficient in controlling pathogens .This review addresses the general view of lantana camara and various properties of fungal endophytes.

Keywords :Lantana camara Linn., fungal endophytes, bioactive compounds, stress conditions.

Introduction

Lantana L., with Persian name of 'shahpasand', is a genus comprising of about 150 perennial flowering plant species belonging to the Verbenaceae family and are native of Americas and Africa tropical regions. Among these, L. camara is undoubtedly the most beautiful ornamental plant species widely cultivated as a shrub in tropical, subtropical and temperate climates (Babaahmadi et al, 2018).The Plant is popular as wild sage, Surinam Tea Plant, Spanish flag, red sage, lantana weed and West Indian lantana. In India, L. camara was introduced before 19th century and currently the plant is widely distributed throughout India, particularly in a moderate to high summer rainfall and well-drained sloping sites. Divergent parts of L. camara are reservoirs of wide variety of unexplored bioactive compounds like essential oils, phenolic compounds, flavonoids, carbohydrates, proteins, alkaloids, glycosides, iridoid glycosides, phenyl ethanoid, oligosaccharides, quinine, saponins, steroids, triterpens, sesquiterpenoides and tannin as superior phytochemical groups (Venkatachalam T et al,2011; telma). The leaves of L. camara are used in the treatment of various disorders like pulmonary asthma, bronchitis, rheumatism, measles, chicken pox, skin injuries, scabies and leprosy [Deena and Thoppil 2000; Nayak et al, 2009;]. The essential oil of L.camara leaves contains a high amount of hydrocarbons, terpenes like monoterpenes, sesquiterpenes, triterpenes and their oxygenated derivatives, terpenoids, and is known to exhibit insecticidal and repellent activities besides inhibiting the growth of various miroorganisms like *Aspergillus niger*, *Pseudomonas aeruginosa*, and *Candida albicans*.The medicinal use, phytochemistry, pharmacological activities, toxicology make lantana special and it is having certain future prospects for the further scientific investigation for the development of effective bioactive compounds (Shyamal et al,2018).

Fungal endophytes

Endophytic fungi are microorganisms found to depict an association with the plants internal tissues either during part or whole of the life span without causing any pathogenic symptoms (Song et al, 2017). The fungi and host interaction constitutes a continuum from latent pathogen and/or saprotrophs to obligate mutualism (Clay & Schardl 2002). In case of mutualistic associations, the plants interact with the endophytes thereby, modulating various processes in them to produce myriad of important molecules such as secondary metabolites beneficial for both the microbes and the host (Kusari et al, 2012). Accumulated evidence has shown that endophytes harboured in the plants have gained impetus in the recent past due to the fact that these not only play a critical role in the normal physiological processes of the plant but also provide tolerance against horde of biotic or abiotic stresses including plant pests, extreme temperature, salinity, osmotic shock and drought (Hartley et al, 2015; Potshangbam et al, 2017; Radhakrishnan et al, 2013). Under variousenvironmental cues, a variety of metabolites known to be glycosides, alkaloids,lipids, terpenoids, isoprenoids,polyketides, etc. in nature are produced by the fungal endophytes which depict antioxidative, anti-cancerous, antimicrobial bioactivities etc. (Hamed et al, 2015; Silva-Hughes et al, 2015; Zhang et al, 2016). Due to these, endophytes from an untapped diverse habitat are a significant source of novel and natural drugs. Consequently, exploring endophytic fungi from diverse plant species in different geographical habitats would provide opportunities to discover novel and natural drugs. However, as per literature survey, very scarce information is available regarding the endophytes diversity and its multifunctional potential from different species of Lantana camara. Therefore, an inventory of the endophytes and the various secondary metabolites and enzymes from different species of Lantana camara will provide us with varied sources of pharmaceutical drugs implicated in diverse functions for the overall well-being of the plants and animals. Keeping this in mind, this review paper will provide for the first time an evidence of endophytic fungi community composition and diversity within the Lantana camera species and will also investigate them for multifaceted activities like antimicrobial, and anticancer etc.

Fungal endophytes from Lantana camara

Lantana camara is the residence of certain fungal endophytes which are living in certain parts of lantana (Table1), these isolates are *Helminthosporium sp* , *Fusarium oxysporum*, *Alternaria alternata*, *Aspergillus nidulans* and so on. The fungal endophytes are identified according to their colony and morphological characteristics(Table2).

Table1

Location of fungal endophytes isolated from lantana camara

Host plant	Plant part	Fungal isolate
Lantana camara	Leaves	*Helminthosporium species*
Lantana camara	Leaves	*Aspergillus nidulans*
Lantana camara	Stem	*Fusarium oxysporum*
Lantana camara	Stem	*Alternaria alternata*

Table2

Features of fungal isolates isolated from lantana camara

Fungal isolates	**Colony characteristics**	**Morphology**
Aspergillus nidulans	dark green with orange to yellow, reverse is purplish to olive, with moderate growth.	Hyphae are septate and hyaline, conidial heads are columnar
Helminthosporium sp	Olive green to black from the front and black from the reverse. Texture is velvety to wooly.	Hyphae are septate and produces conidia and conidiophores
Fusarium oxysporum	Pale or white coloured colonies	Microconidia are non septate or cylindrical
Alternaria alternata	Colonies are black to olivaceous black or grayish.	Hyphae are septate and brown

Characterization of fungal endophytes from lantana camara

The *Aspergillus nidulans* is capable to produce certain bioactive compounds, such as 1-docosanol, 1-octadecanol, all-trans-anhydrorhodovibrin, perillol, phytol, n-hepta-decanol-1 and n-hexadecanoic acid (El-Sayed et al, 2017).The extract of these bioactive compounds are having high insecticidal activity because of the presence of phytochemicals such as primary fatty alcohol, saturated fatty acid, monoterpenes, tetraterpenoid, and unsaturated fatty acid in them (Demain et al,2000). *Aspergillus nidulans* were also labeled as possible biologically effective isolated against S. littoralis. It exhibit an indisputable larvicidal activity in addition to hindrance to the larval growth and lengthing in the period of *S.littoralis*life cycle stages (Namasivayam et al, 2014, Kaur et al, 2016). The larval fatality may be associated with the direct insecticidal action due to feeding interference or gustatory repellency or deterioration in the food ingestion after feeding on leaves treated with the fungal extracts (El-Sayed et al, 2015, Edriss et al,2012). The extract of *Alternaria alternata* have the capability to induce indicative inhibitory effect on survival and reproductive potential of *Spodoptera litura* , and the larval fatality rate increases with proportional to the fungal action (Desire et al, 2014.,Namasivayam et al, 2014, Kaur et al., 2016). Penicinoline, it is an alkaloid produced by *penicillium* species which having tenacious insecticidal activity against the sucking pest, *Aphis gossypii* Glover (Theantana et al, 2012, Shao et al, 2010). The fungal endophytes which are isolated from lantana are having antifungal activity so these can be used for the treatment of infectious disease like taro life blight caused by *phytophthora colocasiae* (chung et al. 2008). Other than these bioactive compounds the endophytes are capable to produce some other bioactive metabolites, they can be identified through phytochemical screening and these compounds are cardiac glycoside, tannins, and phenols. These metabolites are having certain anti- pathogenic properties and they exhibit effective participation in plant defence mechanism as well.

The fungal endophytes are also able to produce certain enzymes, known for providing plant defence against pathogens and at the same time breakdown of nutrients also. Lytic enzymes such as amylase, proteinase, lipase and cellulose are known for its role of attack against plant pathogens and other antimicrobial properties (Martínez et al,2019). These enzymes having the ability to antagonize the pathogenic fungi through the competition of nutrients, by this they suppressing the growth of pathogens (Desire et al 2014) and also the enzyme lipase can degrade lipids.The endophytes are known to produce amylase for the starch degradation in plants and the *Geotrichium* species of lantana camara are capable to produce laccases which is an enzyme having antioxidative properties and also it can be used as efficient biocontrol agent (Figen et al,2006), It involves in the degradation of lignin and maintains the pathogenicity process in plants. For the assessment of role of endophytes in the field of plant defence, invitro isolation and characterization of enzymes and metabolites are compulsion (Saxena et al,2014). The formation of large number of secondary metabolites by endophytic fungi is a fascinating aspect with other possible functional applications.

Fungal Endophyte as an Elicitor

The fungal endophytes are beneficial to plants in many ways. The fungal endophytes act as stimulant in the synthesis of secondary metabolites namely triterpenoids—ursolic acid (UA), oleanolic acid (OA) and betulinic acid in lantana. *Piriformosporaindica*, a root endophytic fungi, have the ability to increase production of bioactive compounds like aristolochic acid in Aristolochia elegans Mart, artemisinin in A. annua (Sharma and Agrawal2012; Singh et al, 2018) and growth in wide variety of plants such as Coleus forskohlii (Das et al. 2012), Azadirachta indica (Singh et al,2003). Other than these, the fungi impart favorable effects in production of secondary metabolites in plant cultures e.g. on production of podophyllotoxin in cell suspension cultures of *Linum album* .There are different elicitor moieties present in fungi namely chitin and chitosan, known to be biotic elicitors playing a major role in the enhanced production of triterpenoids in lantana camara and also imparting certain defensive mechanisms also. Recent studies have demonstrated the destructive effects of *Alternariaalternata*toxin on the reproduction of *rose aphid*, *Mcrosiphum rosivorum*Zhang (El-Sayed et al, 2020, Ali et al, 2016).

Conclusion

This review gives information about the notorious invasive alien weed called lantana camara and the characteristics of its fungal endophytes. The endophytic fungi from lantana has the ability to produce certain bioactive compounds and enzymes.These enzymes and bioactive compounds have significant properties in the field of agricultural and pharmaceutical areas. These fungal isolates isolated from lantana camara which is having antibacterial, antifungal and anti-larvicidal effect on microbes without harming the host. The formation of large no of secondary metabolites by endophytic fungi is a fascinating aspect with other possible functional applications. The characterization of bioactive compounds from fungal endophytes paved new way in the field of medicinal and agricultural purposes.

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