International Journal of Science and Research (IJSR)
ISSN: 2319-7064
ResearchGate Impact Factor (2018): 0.28 | SJIF (2019): 7.583

Biocontrol Efficiency of Endophytic Bacteria Isolated from *Curcuma Longa*

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Abstract: ***The interaction of diverse communities of microorganisms with the plants helps it to cope up with various functions including growth promotion, yield enhancement and disease management and the microbes derive shelter and nutrients from the host plants [1]. During colonization of the endophytes the microbe resides in almost every internal part of plant ranging from tissues of the underground roots to stem, leaf, flower, fruit and seed. The endophytesare said to actively or passively trigger the physiological changes in the plant cell[2].Since they are superior in growth promotion they tend to give better adaptations against abiotic or biotic stresses [3]. Most of the endophytes are the common soil bacteria (Pseudomonas, Burkholderia and Bacillus) that produce diverse range of secondary metabolites, antibiotics and volatile organics which helps reduce the deleterious effects of pathogens by mechanisms in line with the PGPR [4].According to the phylogenetic view, endophytic bacteria vary between saprophytic bacteria and plant pathogens. They behave as either obligate or facultativebiotrophicsymbionts.***

Keywords: Endophytes, BiotropicSymbionts, Growth Promotion, Phytohormones, Agriculture

1. Introduction

The endophytes are the diverse group of microbial communities present in the endosphere of the plants which are said to make significant contributions to plant health. Endophytes were mentioned first time by Bary in 19th century [5] and discovered by Darnel Germany (1904).

The term "endophyte" is derived from the Greek words "endon" meaning within, and "phyton" meaning plant. They areendosymbionts (bacteria, fungi) found in association with plants for at least part of their life cycle showing no effect on the plant. The definition of endophytes has been redefined to[1, 3, 4,6]. "Endophytes are microbes including bacteria, archaea, fungi, and protists that colonize the plant interior regardless of the outcome of the association"[4]. The endophytes are found across many phyla like the Proteobacteria, Actinobacteria, Firmicutes and Bacteroidetes[4,7–9].The transmission of endophytes takes place vertically (from parent to offspring) or horizontally (among individuals).They are ubiquitous and help to enhance host growth, nutrient acquisition, improve plants ability to tolerate abiotic stress such as drought and enhance resistance to insect's, plant pathogen and mammalian herbivores. Endophytes have selective host i.e., not all endophytes grow in all the plants. Some produce antibiotics against other fungi and bacteria. The infection rate of the endophytes is high when transmitted via seeds.

Endophytes and their uses

Endophytes may benefit host organisms by preventing pathogenic or parasitic organisms from colonising them. Extensive colonizing of the endophytes creates a barrier effect which out - competes the parasite they also produce chemicals which prevents the growth of competitors and pathogenic organisms. They help in the increased expression of the defence related genes [10] . The endophytes and host share a balanced antagonistic relationship with both positive and negative effects depending on the environmental conditions. According to the "*habitat adapted symbiosis*" by Redman *et.al*., "Plants are supposed to associate with certain endophytes that increase resistance and tolerance to the predominant abiotic and biotic stresses of their habitats[38]".

Endophytes are also used to combat pathogens and even cancers in animals and human being [11]. A large number of compounds have been extracted, isolated and characterised from endophytic microbes[12,13].The endophytes are also said to induce insecticidal properties to the host plants[11].

Endophyte promote plant growth by the production of phytohormones[14,15]. Root associated endophytes produce auxins and gibberellins [16]. IAA increase colonisation efficiency [17]. Adenine and adenine ribosides are identified in scot pine as growth promoting compounds [18]. Acetoin and 2,3butanediol which stimulate plant growth are also produced in some bacterial endophytes[19]. Root endophytes like*Acetobacter, Diazotrophicus, Herbaspirillum* species and *Azoarcus*. *Gluconacetobacter, Diazotrophicus* which fix nitrogen also play an important role as nitrogen fixers in a wide taxonomic range.[20].They carry genes which are necessary for biological nitrogen fixation (BNF) which enable them to convert dinitrogen gas (N_2) into usable forms of nitrogen like ammonium and nitrate within the host plant.[21,22].

The use of bacterial endophytes in agriculture has immense potential as it can reduce the environmental impacts caused by chemical fertilizers, especially N fertilizers. With the use of natural symbionts such as bacterial endophytes in the growth of crop plants the use of fertilizers can be reduced potentially making farming more environmentally sustainable in the future. Bacterial endophytes releases antimicrobial compounds helping in developing resistance or tolerance to the host plant from biotic and abiotic stresses by producing siderophores, competing for space and nutrients, and modulating the plant resistance response [23, 24].They also relieve plant stress by blocking the pathway of ethylene

synthesis in plants. The mechanism used by bacterial endophytes to mitigate abiotic stress remains unclear.

Attachment and colonisation of endophytes in plant tissues:

The release of photosyn that esorexudates including organic acids, amino acids and proteins from the root of the plants influences the microbial communities presentintherhizosphere[25]. The bacterial quorum sensing compounds are involved in communication with the plant root and the subsequent colonization process. The host plant genotype and soil composition are considered important in the recruitment of bacterial endophytes by the host plant.

The first step in the colonization process is the attachment of bacterial cells to the plant surface with the help of the chemotactic affinities for root exudates, the bacteria in the vicinity of the roots swim towards them, followed by attachment to the root surface in the potential entry sites at lateral root emergence areas or other openings caused by wounds or mechanical injuries. The bacterial cells produces exopolysaccharides (EPS) which help in the attachment of bacterial cells onto the root surface (the early stage of endophytic colonization).[26]

The intercellular spaces of the plantin the parts of root, stem and leaves are rich in carbohydrates, amino acids, and inorganic nutrients hence the bacterial endophytes tend to occupy this reagion[9,19]. Colonization can be at the tissue level or systemically throughout the plant body[21,25,27]. They are first observed in root hairs, and subsequently in the root cortex [28]. Bacterial endophytes have been observed in the intercellular spaces of mesophyll, and xylem tissues and substomatal areas in leaves and in seeds they are said to colonise different seed parts including the embryo and is also said to mobalize and grow in the developing seedlings during germination and early seedling growth [29].

***Curcuma longa* as a host plant:**

Curcumin, the most important curcuminoid, is used as antioxidant, antimicrobial anti-inflammatory and is even effective against cancer and HIV [30,31] .The underground turmeric rhizome favours growth of various microbial communities which modulates plant growth by the synthesis of biochemicals and secondary metabolites.[32]. Endophytic bacteria when associated with the rhizospheric bacteria exert several beneficial effects on host plants, such as stimulation of plant growth, nitrogen fixation and resistance to plant pathogens [33].

Alkaloids, benzopyranones, chinones, flavonoids, phenolic acids, quinines, steroids, terpenoids, tetralones, xanthones, etc are few of the bioactive compounds produced by the endophytes. [34]. It has been demonstrated that the endophytes isolated from medicinal plants are excellent producers of strong fungicides, bactericidal and cytotoxic metabolites[35].

2. Conclusion

This review deals with the endophytes, their colonization, from recruitment, attachment, and entry to the distribution patterns of bacterial endophytes in the plant endosphere. The secondary metabolites produced by these endophytes are beneficial to the plant and can develop resistance to biotic and abiotic stresses thus helping them cope up with the environmental changes. Endophyte is one of the most promising source of natural bioactive compound[36,37] .The structure of bacterial endophyte communities are varied, dynamic overtime, and attributed to plant source, plant age, tissue type, time of sampling, season and environment [37].

The endophytes can be used in agriculture replacing fertilizers thus reducing the soil and air pollution.

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