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ENDOPHYTIC BACTERIA AS A BUDDING RESERVE OF NEW ANTIBIOTICS

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ABSTRACT

The human population is increasing with an alarming rate ecosystem are depreciating rapidly. A variety of new types of health issues are exploding up. For instance, increase in number of drug-resistant bacteria is a cause of concern. Research on antibiotics and other microbial natural products is decisive in the global fight against the growing problem of antibiotic resistance.[1] It is necessary to find new antibiotics to tackle this problem; and EB are one of the potential sources of novel antibiotics.[2] Antibiotics are useful compounds for treatment of human, farm animal and aquaculture infections. However, due to resistance development of pathogenic microbes to most of the useful antibiotics, there is a continuous necessity for new and powerful anti-infective compounds. This situation fosters the search for new compounds alternatives for the isolation of new compounds with antimicrobial activity. Endophytes are micro-organisms (bacteria and fungi) that live inside the living plant tissues for at least part of their life without causing any apparent disease symptoms in the host.[1] Endophytes thus represent a subset of microbes that reside in unique niches and, if explored properly, may prove to be a reservoir of bioactive principles.[3]

INTRODUCTION

The endophytic bacteria, actinomycetes and fungi play an active role in the production of bioactive compounds. Bioactive compounds like alkaloids, steroids, terpenoids, peptides, polyketones, flavonoids, quinols and phenols, and the natural insecticide azadirachtin produced by endophytic bacteria have agricultural, industrial and medical applications[4] Endophytic microbes spend most of their life cycle within the plant tissues without causing any visible damage to the host plant. Many endophytes also secrete specialized metabolites or biologically active compounds.[5] Endophytic bacteria are also having the potential due to their ability to produce plant growth hormones, phosphate solubilization, nutrient acquisition and fixation of N_2.The EB appears to be a potential source of novel antibiotics. It is well known fact that until now the soil bacteria have been the source for most of the antibiotics. Now the EB seem to be a promising potential source of novel antibiotics. Antibiotics produced by endophytes includes to several structural classes such as peptides, alkaloids steroids, quininesphenols, terpenoids, flavonoids.[5]

Types

- ***Obligate endophytes***: It lodge inside plant tissues throughout their lifespan.
- ***Facultative endophytes***: They are capable to survive in the soil, on the plant surface, inside the plants as well as on artificial nutrients. They are widely disseminated across the plant kingdom and can be isolated from various plant species.

Endophytic bacteria

Endophytes are micro-organisms that are found in many important medicinal plants, weeds, and ornamental and fruit trees from wild and disciplined settings. Both endophytic bacteria and endophytic fungi can co-exist in a single host plant.[3] The natural products obtained from endophytic microbes are found to be antimicrobial, antiviral, anticancer, antioxidants, anti-diabetic and immunosuppressant. Natural products are metabolites from micro-organisms, plants and animals. An example of a natural product is the anticancer-drug, paclitaxel (Taxol) is from Yew tree, Taxus wallachiana. Some examples of the novel antibiotics produced by endophytic bacteria are Ecomycins, Pseudomycins, Munumbicins, Kakadumycins.[4] More than 300 endophytic actinobacteria and bacteria belonging to the genera *Streptomyces, Nocardiopsis, Brevibacterium, Microbacterium, Tsukamurella, Arthrobacter, Brachybacterium, Nocardia, Rhodococcus, Kocuria, Nocardioides*, and *Pseudonocardia* were isolated from different tissues of *Dracaena cochinchinensis* Lour. (a traditional Chinese medicine known as dragon’s blood). of these, 17 strains having antimicrobial and anthracyclines-producing activities also showed anti-fungal and cytotoxic activities against two human cancer cell lines, MCF-7 and Hep G2.[6] The EB are also known to increase host plants resistance to pathogens and to promote biological nitrogen fixation as stated by

Bhore *et al*. The endophytes are known to boost the growth and development of host plants in varied environmental and ecological conditions. Several EB have been shown to produce natural products like phytohormones, low molecular weight compounds, enzymes, siderophores, and antibiotics.

Antibiotics and Drugs produced by some endophytic bacteria

Compounds	Endophytic bacteria	Biological activity
Ecomycin	*Pseudomonas viridiflava*	Anti-fungal
Bacilysocin	*B. subtilis* 168	Anti-fungal
Nystatin	*Streptomyces noursei*	Anti-fungal
KB425796-A	*Paenibacillus* sp. 530603	Anti-fungal
Bacillomycin	*B. subtilis, B. amyloliquefaciens*	Anti-fungal, Hemolytic
Munumbicin	*Streptomyces* NRRL 30562	Antibacterial
Harmaomycin	*Streptomyces* sp.	Antibacterial
Subtilin	*B. subtilis*	Antibacterial
Tetracyclin	*Streptomyces remosus* and *S. aureofaciens*	Antibacterial
Bacteriocins	*B. subtilis*	Antibacterial
Amicoumacin	*B. subtilis*	Antibacterial, anti-inflammatory
Artemisinin	*Pseudonocardia* sp.	Anti-malarial
Coronamycin	*Streptomyces* sp.	Anti-malarial
Albaflavenol B	*Streptomyces* sp.	As sesquiterpene
Spectinomycin	*Streptomyces spectabilis*	Anti-tuberculosis
Treponemycin	*Streptomyces* Strain MS-6-6	Anti-tuberculous
Androprostamines	*Streptomyces* sp. MK932-CF8	Anti-prostate cancer
Camptothecine	*Lysinibacillus* sp. and *B. cereus*	Anti-cancer
Indolocarbazoles	*Streptomyces* sp.	Anti-cancer
Doxorubicin	*Streptomyces* sp.	Treatment of Breast cancers and tumors
Anthracycline	*Streptomyces* sp. YIM66403	Antitumor
Daptomycin	*Streptomyces roseoporous*	SBacterial infections of skin and underlying tissues
Monensin	*Streptomyces cinnamonensis*	Prevent coccidiosis
Mytomycin C	*Streptomyces caespitosus and S. lavendulae*	Chemotherapeutic agent
Saadamycin	*Streptomyces* sp. Hedaya48,	Anti-dermatophyte
Strepturidin	*Streptomyces albus* DSM 40763	Immunotherapy
Thaxtomin A	*Streptomyces scabies*	Cellulose synthesis inhibitor
Xiamycin	*Streptomyces* sp.	Anti HIV activity
β-exotoxin	*B. thuringiensis*	Insecticidal

Future trends

World human population is increasing with a startling rate; and a variety of new types of health issues are popping up. For instance, increase in number of drug-resistant bacteria is a cause of concern. Research on antibiotics and other microbial natural products is paramount in the global fight against the growing problem of antibiotic resistance. It is necessary to find new antibiotics to confront this problem. As our understanding of endophytic bacteria continues to grow, the potential to exploit their unique characteristics of bioactive compound synthesis alone or with plants is also increasing day by day. The plant benefits enhanced by combined application of beneficial microorganisms in the form of bio-fertilizer have become an alternative tool for organic farming. Exploitation of endophytic bacteria as a plant growth-promoting agent further necessitates our ability to understand and utilize bacterial endophytes in agriculture under integrated bio-fertilizer technology programme. How endophytes modulate the physiology of plant and its metabolism and how they use the intermediary substances of primary and secondary metabolism as nutrition and precursor to produce either novel compounds or enhance the existing important secondary metabolites are still largely unknown. To sum up, the EB do have a huge potential in bioprospecting; and in the future, these EB are going to serve as one of the potential sources of novel antibiotics. For this reason, the current scenario warrants the expansive research to explore untapped, underutilized and neglected EB.[7] However, an effective and efficient cross-talk amongst chemists, ethnobotanists, microbiologists, molecular biologists, pharmacists, taxonomists and toxicologists is essential in exploring EB for novel antibiotics and other natural products.The ultimate aim of bioprospecting for novel compounds is to isolate compounds which are safe and efficacious for human use.

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