Insect-Associated Microorganisms as a Source for Novel Secondary Metabolites

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Introduction

Everyday life is significantly influenced by natural products, with nearly all antibiotics and anti-cancer compounds currently in clinical use originating from or being derived from natural sources. However, the growing resistance to these antibiotics emphasizes the pressing need for the exploration of novel bioactive natural products. Various strategies are currently employed to discover such compounds, and in this pursuit, insects are emerging as a promising and innovative source of bacteria and fungi capable of producing unique secondary metabolites. Insects, being the most diverse group of animals on Earth with an evolutionary history dating back approximately 400 million years, have demonstrated remarkable adaptations to diverse environments.

Various Insect-Associated Microorganisms

1. Photorhabdus bacteria

The Gram-negative Photorhabdus bacteria exhibit a dual lifestyle as both mutualists of Heterorhabditis nematodes and pathogens of insects. This unique nematode-bacterium partnership has proven effective in controlling a broad spectrum of agricultural insect pests. Photorhabdus bacteria are prolific producers of various small molecules, which play pivotal biological roles in regulating their dual functions. Notably, several secondary metabolites (SM) synthesized by these bacteria are crucial for maintaining a monoxenic infection within the insect host. Additionally, these metabolites serve to prevent contamination of the cadaver by soil microbes and deter predation by arthropods (Stock et al., 2017).

2.Bacillus thuringiensis

The entomopathogenic bacteria such as Bacillus thuringiensis (Bt) have seen increased utilization in the agricultural biotechnology domain. The pest-specific characteristics of various Bt strains have triggered a dynamic interplay resembling an arms race between agricultural biotechnology and insects, akin to the ongoing challenges faced by the pharmaceutical industry against multi-resistant bacteria. Beyond its role in generating protein toxins, B. thuringiensis exhibits potential as a producer of an acyl homoserine lactone lactonase. This enzyme has the capability to dampen the pathogenicity of plant pathogenic bacteria. Additionally, B. thuringiensis produces zwittermicin A, a potent antibiotic and anti-fungal compound (Zhou et al., 2008).

3. Yersinia pseudotuberculosis

The interplay between insects and microorganisms has found application in models for human drug discovery. Investigations into host defence mechanisms, such as Phenol oxidase and superoxide dismutase, have been integral to this exploration. Remarkably, the wax moth (Galleria mellonella), which proves susceptible to the human enteropathogenYersinia pseudotuberculosis, has emerged as a successful infection model, surpassing other invertebrates in its utility for such studies (Champion et al., 2009).

4.Cryptococcus rajasthanensis

Yeast capable of producing melanin was isolated from the gut microflora of the insect Bombyx mori and identified as Cryptococcus rajasthanensis. The melanin pigment was assessed for its potent bioactive properties, demonstrating antimicrobial, antioxidant, anti-inflammatory, and anticancer activities. These findings

underscore the therapeutic potential of the extracted melanin pigment. Beyond its biological activities, the Cryptococcus extract displayed killer toxin activity against the pathogenic yeast Candida albicans(Barretto et al., 2020).

Conclusion:

The future holds the potential for discovering numerous novel bioactive natural compounds from microorganisms associated with insects, whether they are entomopathogenic or symbiotic in nature. This untapped source presents a promising avenue for exploration. The current era is opportune for such endeavours, given the ready availability of advanced analytical tools like sensitive and affordable mass spectrometers, as well as molecular tools such as rapid and affordable whole-genome sequencing. Undoubtedly, the realm of natural product research and drug discovery, in general, stands to gain significant advantages from the exploration of microorganisms associated with insects in the times ahead.

Reference

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