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REVIEW

Entomopathogenic fungi in crops protection with an emphasis on bioactive metabolites and biological activities

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Abstract

Plant pathogens with their abundance are harmful and cause huge damage to different agricultural crops and economy of a country as well as lead towards the shortage of food for humans. For their management, the utilization of entomopathogenic fungi is an eco-friendly technique, sustainable to the environment, safe for humans and has promising effect over chemical-based pesticides. This process requires a biochemical mechanism, including the production of enzymes, toxins, and other metabolites that facilitate host infection and invasion. Essential enzymes such as chitinase, proteinase, and lipase play a direct role in breaking down the host cuticle, the primary barrier to EPF (Entomopathogenic Fungi) infection. Additionally, secondary metabolites such as destruxins in *Metarhizium*, beauvericin in *Beauveria*, hirsutellides in *Hirsutella*, isarolides in *Isaria*, cordyols in *Cordyceps*, and vertihemipterins in *Verticillium*, among others, act both directly and indirectly to disable the defense mechanisms of insect hosts, thereby accelerating the EPF infection process. The chemical composition of these secondary metabolites varies, ranging from simple non-peptide pigments such as oosporine to highly complex piperazine derivatives such as vertihemiptellides. The biocontrol efficacy of EPF is extensively studied, with numerous fungal strains commercially available on a large scale for managing arthropod pests. This review emphasizes the role of proteins and enzymes against crop pathogens, detailing their mode of action, and describing the metabolites from entomopathogenic fungi and their biological activities. In doing so, these findings contribute to establishing a symbiotic equilibrium between agricultural productivity and environmental conservation.

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