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Plant chemical defense: Synthesis, distribution and role of phytoalexins and phytoanticipins against biotic stresses

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Abstract

Biotic stresses caused by pathogens (bacteria, fungi, and nematodes) and insect herbivores significantly constrain global crop productivity and threaten food security. To recognize herbivore and pathogen attacks, plants have developed sophisticated mechanisms to defend themselves by converting those signals into appropriate biochemical and physiological responses. Plant defense mechanisms against stresses can be divided into structural (physical barriers such as trichomes, thorns, waxy or thick cuticle, *etc.*) and chemical defenses (both inducible and constitutive defenses). Phytoalexins are a part of the plant's inducible defense system. These low molecular weight antimicrobial compounds are synthesized de novo in response to a biotic attack or threat. Due to their antimicrobial activity, they disrupt the cell membrane, inhibit enzymatic activity, and interfere with the pathogen/herbivore's cellular respiration. Additionally, phytoalexins act as insect antifeedants by producing compounds unpalatable to the insects. Unlike phytoalexins, constitutive chemical defense or phytoanticipins are pre-formed and are already present in healthy plant tissue. These serve as a first line of defense against potential herbivores or pathogens. When plant tissues are damaged or under attack, phytoanticipins spring into action, directly combating threats by disrupting pathogen membranes or blocking essential enzymes needed for nutrient uptake. This paper provides a comprehensive overview of plant chemical defenses, exploring how phytoalexins and phytoanticipins are produced, stored, and deployed against pathogens and insect herbivores.

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