

Impact of Root Rot Pathogens on Secondary Metabolite Production in Herbal Crops

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Abstract: Root rot diseases caused by soilborne pathogens pose a serious threat to herbal crop production, compromising not only plant stand and yield but also the biochemical quality of harvested material. This paper investigates how infection by primary root rot pathogens, including *Fusarium solani*, *Pythium aphanidermatum*, *Phytophthora cinnamomi*, and *Rhizoctonia solani*, affects secondary metabolite accumulation in six commercially important herbal crops: *Withania somnifera*, *Glycyrrhiza glabra*, *Valeriana officinalis*, *Piper longum*, *Tinospora cordifolia*, and *Asparagus racemosus*. A combination of greenhouse inoculation trials, soil microbiome characterization, and phytochemical profiling was used to assess the relationship between infection severity and the concentration of key bioactive compounds including withanolides, glycyrrhizin, valerenic acid, piperine, tinosporin, and shatavarin. Results showed that root rot significantly reduced bioactive compound concentrations across all species, with reductions ranging from 22% to 51% depending on pathogen species and host. *Fusarium solani* caused the greatest metabolite suppression, while *Pythium aphanidermatum* had the most severe effect on root biomass. Soil microbiome data revealed that disease-suppressive bacterial communities were significantly depleted in high-infection plots, correlating with worse outcomes. The study contributes quantitative evidence of the metabolite quality penalty imposed by root rot and discusses implications for cultivation practices, soil health management, and quality assurance in herbal raw material supply chains.

Keywords: Root rot, *Fusarium solani*, *Rhizoctonia solani*, secondary metabolites, herbal crops, soilborne pathogens, bioactive compounds