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Elicitation-Based Biotechnological Interventions to Promote Hairy Root Growth and Biomass Yield

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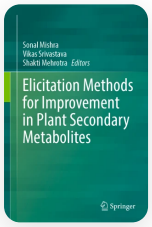

Elicitation Methods for Improvement in Plant Secondary Metabolites

Kahkashan Khatoon, Zafar Iqbal Warsi, Tahreem Junaid, Syed Saema, Gazala Parween & Laiq Ur Rahman

Abstract

Hairy root cultures, produced through genetic transformation by *Agrobacterium rhizogenes*,represent a highly dependable and metabolically efficient biosynthetic system. Their rapid growth and genetic stability make them ideal for the sustained production of biomass and high-value secondary metabolites under controlled in vitro conditions. Owing to their high transgene expression capabilities, they hold immense promise for scalable bioactive compound production and molecular farming across pharmaceutical and agricultural sectors. This chapter explores advanced biotechnological strategies

aimed at enhancing hairy root productivity through elicitation and optimization of culture conditions. Particular emphasis is placed on the critical roles of carbon sources especially sucrose, macro- and micronutrients in regulating metabolic fluxes and supporting robust root development. Furthermore, the synergistic influence of physiological factors such as oxygen availability, temperature regimes, and light intensity on biomass accumulation and metabolite biosynthesis is thoroughly examined. Elicitors like methyl jasmonate, salicylic acid, and sodium nitroprusside are discussed for their ability to activate plant defense pathways and stimulate secondary metabolism. Integration of innovative bioreactor designs and precise environmental control systems significantly enhances scalability and yield. Overall, this comprehensive analysis highlights hairy root cultures as a transformative tool in plant biotechnology, offering sustainable and efficient platforms for the commercial production of therapeutically valuable natural products.