

## Chapter 2

# A Critical Review on Biotechnological Interventions for Production and Yield Enhancement of Secondary Metabolites in Hairy Root Cultures



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**Abstract** In the past three decades, differentiated hairy root culture-related researches gained a great attention due to the equal or greater bio-production capacity of low amount, high-value secondary metabolites as compared to their parent plants with several advantages over undifferentiated cell suspension cultures in plants. This was mainly because hairy roots are capable of auxin-independent rapid growth and are genetically and biochemically stable, with high productivity and suitability for adaptation to large-scale systems. Nowadays, hairy root cultures of various plant species offer a novel promising opportunity and great prospects for in vitro mass production of economically important bioactive metabolites. At present, the productivity of desired compounds by hairy root cultures is generally too low to fulfill the demands of pharmaceutical industry owing to various biological and technological limitations. Screening and selection for high-yielding root lines and optimization of the culture media and the culture conditions like type of nutrient medium, salt strength, source of carbon and concentration, source of nitrogen and the ratio of  $\text{NH}_4^+/\text{NO}_3^-$ , concentration of phosphate, inoculum density, hydrogen ion concentration, temperature, and light intensity and quality have been taken as yield enhancement strategies among others, to produce desired secondary metabolites using hairy root cultures. Feasibility of commercial application of hairy root culture in bioreactors requires several optimization steps. This review highlights some of the recent progress and outlines future prospects for metabolite production and yield enhancement approaches in hairy root cultures for producing bioactive substances.

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