

## ANTIOXIDANTS IN HAIRY ROOT CULTURES

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Numerous secondary metabolites (SM) of higher plants have been demonstrated to protect cells, in *in vitro* experiments, against oxidative damage by inhibiting or quenching free radicals and reactive oxygen species. These natural antioxidants play important role in plant acclimation and adaptation to environmental challenges, but are also beneficial for human health. Last years much interest has been attracted to natural antioxidants for medicinal use as anti-inflammatory, anti-aging, anti-atherosclerosis, anticancer, and antidiabetic agents.

Most of natural antioxidants are phenolics: flavonoids (flavanols, iso flavones, flavones, catchins, flavanones), phenolic acids and their derivatives, coumarins, and polyfunctional organic acids, that occur in all parts of the plant - wood, bark, stems, leaves, fruit, roots, flowers, pollen and seeds. The effective extraction and proper assessment of antioxidants in medicinal plants is crucial to explore the potential antioxidant sources and promote their application in pharmaceuticals, food additives and cosmetics.

Yields of SM obtained by traditional solvent extraction are usually low and need a big amount of plant raw material and enhancement of extraction by temperature US or HF treatment. This may lead to destruction of the substances, which are chemically unstable.

"Hairy root" system, obtained by transforming plant tissues with the "natural genetic engineer *Agrobacterium rhizogenes*", is one of the promising ways for the production of SM as it allows to manipulate the biosynthetic routes to increase the production and accumulation of specific compounds.

Hairy roots are characterized by high growth rate, genetic stability and growth in hormone free media and can produce amounts of secondary metabolites comparable and higher to that of the intact plants. Over the last years the roots have been used for a variety of purposes, such as metabolic engineering, recombinant protein production, phytoremediation, plant-plant interaction.

In our study we focused specifically on recent developments in hairy root application for the production of different classes of natural antioxidants. Over 200 results published in journals indexed in the Web of Science and Scopus databases over the last 30 years have been processed regarding phenolic acids, xanthenes, quinones, and caffeic acids and their derivatives, stilbenoids, lignans and isoflavonoids in hairy root cultures. Various aspects of their bioactivities; biotechnological strategies including methods for mother plant transformations, enhancing the production of valuable biological active substances; optimization of culture medium and culture conditions; elicitation; application of phytohormones in medium; metabolic engineering; and scale-up to bioreactors were followed. Publication is planning in 2023.