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Silica-based aerogels as functional materials supporting transgenic root proliferation and bioactive metabolite production

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Plant, using their secondary metabolism pathways, produce a wide range of bioactive compounds that can be utilized by the pharmaceutical industry. Many plant-derived molecules exhibit anticancer activity, which makes them interesting candidates for cancer treatment drugs. Transfer of plant biomass to a culture system with strictly controlled parameters (in vitro system) allows for the optimization of the process of secondary metabolites biosynthesis and makes plant-derived molecule production independent from environmental variability or geographical, ecological, or political constraints. In vitro conditions provide the unique ability to modify culture systems by implementation of bioengineering techniques aimed at intensifying the production of desired secondary metabolites. Actually, the most effective bioengineering techniques for enhanced secondary metabolite production are: elicitation (induction of secondary metabolism pathways by biotic or abiotic agents), immobilization of biomass (its spatial confinement by means of inert media), and in situ product removal techniques (reception of products into an additional phase of the culture system limiting negative feedback of secondary metabolism pathways). Furthermore, the specificity of the plant biomass in vitro culture also makes it possible to scale up the bioprocess effectively using bioreactors.

The aim of the study was to develop a novel aerogel-based *in vitro* system for the enhanced biosynthesis of secondary metabolites. The influence of (i) aerogel form, (ii) the pore size in aerogel, (iii) the aerogel functionalization, and (iv) chitosan concentration in hybrid silica-chitosan aerogel on the *Rindera graeca* transgenic root biomass proliferation and secondary metabolite (i.e., naphthoquinone) production have been determined.

The highest yield of naphthoquinone production has been observed for transgenic root cultures using hybrid silica-chitosan aerogel containing 40%$_{m/m}$ of chitosan. In the case of plant biomass proliferation, the highest value of fresh biomass increase has been noticed for transgenic root cultures using silica aerogel with methyl groups.

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