

Polymer-based platforms/scaffolds for enhanced growth of plant organs and efficient secretion of metabolites in a single-use bioreactor system

For millennia, plants are recognized as an invaluable source of natural compounds exhibiting biological activities and functional ingredients of pharmaceutical preparations. Nowadays, the pharmaceutical industry utilizes plants as renewable feedstock and a source of potential chemotherapists in the development of novel anticancer drugs. However, in many cases, the extraction of plant metabolites from plant biomass harvested from natural sources is currently restricted by a range of geographical, ecological or political limitations in the law. The application of modern biotechnological techniques, such as *in vitro* cultures of plant biomass in various forms, i.e. whole plants, isolated plant organs/tissues or suspended plant cell, allows for efficient production of plant biomass and plant bioproducts, independently from seasonal variabilities of the biomass in the natural environment. Additionally, *in vitro* cultures of isolated plant organs/tissues/cells allow optimizing the culture conditions, which leads to exceeding the native levels of biomass or plant metabolites productivities observed in wild plant specimens. In many cases, pharmaceutically valuable plant secondary metabolites accumulate in roots. That is why the biomass of *in vitro* established transgenic roots (synonym: hairy roots) is recognized as an efficient source of plant-derived compounds.

The basic aim of the project is to develop a novel *in vitro* system for cultures of plant organs allowing for enhanced production of transgenic roots secreting pharmaceutically valuable plant metabolites. As an innovative approach, polymer-based platforms/scaffolds are introduced for immobilization of transgenic roots and the protection of such specific plant organs from mechanically-derived destruction effects that occurred in bioreactors. Transgenic roots immobilized on polymer-based platforms/scaffolds will be maintained in a single-use bioreactor equipped with disposable culture bags. In single-use bioreactors, gentle culture conditions are achieved by an untypical method of culture medium mixing, which is accomplished by continuous wave-induced agitation resulted from continuous oscillatory up-and-down movements of the whole disposable culture bag. These types of specific bioreactors are particularly feasible for establish cultures of fragile biomass e.g. for *in vitro* cultures of 3D-integrated organs or tissues, or even complete organisms.

The project relies on two main stages of the experimental studies: (i) screening of suitable polymer material and the development of polymer-based platforms/scaffolds supporting the growth of transgenic roots and secretion of metabolites, (ii) optimization of wave-induced agitation conditions for cultures of transgenic roots biomass immobilized on polymer-based platforms/scaffolds for maximization of transgenic roots growth and secretion of desired bioproducts performed in the single-use bioreactor. Furthermore, mathematical description of the observed effects will allow correct interpretation of the phenomena that occurred in disposable bioreactor and related to the transgenic roots biomass growth and biosynthesis of the pharmaceutically valuable compounds.

The main outcome of the project will be the development of the innovative and original procedure for highly-efficient bioreactor cultures of transgenic roots characterized by intensive biosynthesis of desired pharmaceutically valuable plant metabolites. The results obtained during the implementation of the project assumptions will let to formulate conclusions constituting significant scientific achievements in the discipline of chemical and process engineering, in the field of *in vitro* bioprocessing of plant organs. From the practical point of view, which concerns socio-economic environment, as well as external stakeholders of the science activities, the development of such novel, the innovative and original procedure for transgenic root cultures and its subsequent practical implementation in bioengineering, will allow for a highly-efficient production of a range of pharmaceutically valuable natural (i.e. plant-derived) biologically active compounds. Moreover, the internationally renowned research laboratories will benefit from the results of the proposed project.