

Description of research topic

Institute: The Franciszek Górski Institute of Plant Physiology Polish Academy of Sciences (IPP PAS).

Title: Biochemical system of glandular trichome microenvironment, its biocatalytic properties and potential in biotechnology.

The research topic is carried out as part of the OPUS research project no 2023/49/B/NZ1/02898 in the Franciszek Górski Institute of Plant Physiology, Polish Academy of Sciences.

Scientific discipline: Biological Sciences

Name of potential supervisor: Dr. hab. Piotr Waligórski (IPP PAS); Dr. Paweł Rodziewicz (IPP PAS), p.rodziewicz@ifr-pan.edu.pl

Background information: Plant glandular trichomes are epidermal structures specialized in the production, secretion and storage of a wide range of secondary metabolites. Many of these compounds have potent biological activities, and are used as fragrances, dyes, plant growth agents, pesticides and, above all, pharmaceuticals, e.g. cannabinoids.

In the project, we want to investigate the microenvironment of glandular trichomes in cannabis and tomatoes species at several levels of cellular organization, i.e. metabolomic, proteomic and transcriptomic. In the next step, we plan to investigate the biocatalytic properties of the trichome exudates and recreate their microenvironment, for example, develop catalytically active micellar models. The research results may lead to the discovery of new enzymes operating *ex vivo* in glandular trichomes as well as metabolomic components involved in maintaining activity of the enzymes in hydrophobic conditions. Moreover, catalytic research on biomimetically designed microemulsions may give insights into biocatalysis under water-limited conditions. Also, combining this approach with genetic engineering may provide the basis for the development of a new biotechnological approach to the synthesis of secondary metabolites, free from the typical limitations met in enzymatic catalysis, metabolically engineered microbial hosts, and natural producers.

The doctoral scholarship will be financed as part of the research scholarship provided for in the project OPUS no 2023/49/B/NZ1/02898.

The main questions to be addressed in the project:

- Is it common for plants containing glandular trichomes to secrete catalytically active proteins into their exudates? What is the nature of these proteins/enzymes and what function do they provide for a plant? (*Plant biology; Biochemistry; Proteomics*)
- Do glandular trichomes secrete molecules which play a role in providing optimal conditions for enzymatic reaction in highly hydrophobic trichome microenvironment? What is the nature of such compounds? (*Plant biology; Biochemistry, Metabolomics*)
- Can biocatalytical solutions found in glandular trichomes provide new concepts for development of new strategies of secondary metabolite production? (*Biocatalysis, Biotechnology*)

Information on the methods/description of work: To realize the objectives, we will use techniques including GC/MS/MS, HPLC/MS/MS, MALDI-TOF/TOF in order to perform metabolomic and proteomic identifications. We also plan to include mRNA sequencing data obtained from Illumina NGS platforms in order to identify full genetic sequences of secreted proteins, and perhaps also genetic regulatory elements. In the project we will synthesize the genes of identified proteins and employ newest solutions in genetic engineering of microbial hosts. Microemulsions hosting an enzyme will be design with the notion of biomimetics (exudates-like). Chromatographic and spectrophotometric methods will be used to monitor the activities of the enzymatic reactions.

Requirements from the candidate:

- MSc in natural sciences, e.g. biotechnology, biology, chemistry or related fields,
- interest in science and R&D,
- willingness to acquire knowledge and develop skills in the field of plant biochemistry, molecular biology, analytics, genetic engineering, enzyme catalysis, biotechnology and bioprocesses,
- good knowledge of English in speech and writing,
- ability to organize one's own work,
- creativity, communication skills, conscientiousness.

Place/name of potential collaborator: Project will be realized in consortium with the team of experts from the field of plant science, omic science (IPP PAS, Cracow) genetic engineering and catalysis (ICSC PAS, Cracow), and in cooperation with scientists from University of Amsterdam.

References:

Rodziewicz P., Lorocho S., Marczak Ł., Sickmann A., Kayser O. Cannabinoid synthases and osmoprotective metabolites accumulate in the exudates of *Cannabis sativa* L. glandular trichomes. *Plant Science*, 284:108-116.