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

Plants are a valuable source of valuable compounds (secondary metabolites), which due to their properties are used as plant protection agents, fragrances and flavors, and also as pharmaceuticals. For example, taxol and vinblastine are used in the treatment of cancer, artemisinin is currently the most effective agent in the treatment of malaria, cannabinoids produced by cannabis, and especially cannabidiol, are gaining more attention as potential therapeutics in the treatment of diseases such as cancer, drug-resistant epilepsy, rheumatism, and also as an effective pain-killers. However, very often secondary metabolites are synthesized by plants in small amounts and over a long period of time. Also, their extraction in pure form is complicated and costly. In turn, the chemical synthesis of these compounds is often very complex and uneconomical. Currently, the most promising biotechnological strategy for the production of secondary metabolites is metabolic engineering, which involves the transfer of genes from the biosynthetic pathway to bacterial and yeast cells. However, this approach has many limitations, including low level of synthesis of the desired compounds. For these reasons, new and more effective strategies for the biosynthesis of secondary metabolites are still being sought.

Many plant metabolites with valuable biological properties are synthesized, secreted and stored in specialized structures called secretory trichomes, e.g. the above-mentioned artemisinin and cannabinoids. The aim of the project is to explore the microenvironment of secretory trichomes in cannabis and tomato plant species, identify the components (both metabolites and proteins (enzymes)) and study their biocatalytic potential. Additionally, based on trichome secretions, microemulsion biocatalytic models hosting an enzyme will be developed. The catalytic models will be used to demonstrate biosynthetic reactions of selected secondary metabolites.

The analysis of glandular trichome microenvironment and identification of its components, both metabolites and enzymes, will enable a deeper understanding of their biochemistry and metabolism. The results of the project will also give insights into biosynthesis of the compounds under hydrophobic and emulsion conditions. In addition, the development of the secondary metabolite biosynthesis process based on microemulsion systems will constitute a new and attractive biotechnological approach of the production of valuable secondary metabolites, used for instance as medicines.