

Plant Molecular Farming



The Plant Molecular Farming research group develops new concepts, products and services based on plant bioprocess engineering approaches, as well as synthetic biology using chassis (micro)organisms and integrative biology. The goal is the valorisation of plant biomass as feedstock of molecules for sustainable industrial products and the green biotech sector. The research team develops a range of technologies for the sustainable production of innovative plant-sourced ingredients. We are using plant cell suspension cultures to provide a safe means for the mass production of specialty molecules and proteins. We screen the phytochemistry of our production with a high-throughput mass spectrometry-based biocoverity metabolomics platform.

MAIN EXPERTISE FIELDS

- Plant cells
- Plants produce a wide array of secondary metabolites with biological activities of high interest for the cosmeceutical, nutraceutical, pharmaceutical and agro-chemical industries. The Plant Molecular Farming research group also promotes the valorisation of plant genetic diversity in compliance with access and benefit-sharing (ABS) principles and valorises agro-industrial by-products as a source of commercially relevant molecules. This includes the upcycling of brewery residues, apple/grape pomaces to a source of bio-active compounds.
- Plant cell cultures
- Plants are cultivated both in vitro and as cell suspension cultures to characterise them from the molecular point of view. Among the research activities of the group, there is the study and valorisation of multi-purpose and underutilised crops, such as Cannabis sativa and Urtica dioica, as sources of both fibres and phytochemicals, as well as the cultivation of plant cell cultures, for example apple varieties, for the production of high added-value molecules and the biocoverity of bioactive molecules of microbial origin for plant protection applications.
- Plant cell suspension in bioreactors
- The plant molecular farming research group has a specific expertise in conducting plant production in bioreactor. We benefit from the large set of bioreactors (30+) ranging from lab-scale (1-10L) to pilot-scale (up to 300 L). In this context, we use this specific technology in the frame of plant cellular farming for the production of specialty molecules and proteins
- Synthetic biology and bioprocess engineering

Metabolic engineering combined with comprehensive chemical characterisation techniques are used to develop chassis organisms, plants and plant cell cultures for the sustainable production of known and novel high-value molecules with new or superior biological activities. Once a cell line is established at the laboratory scale, the Plant Molecular Farming research group develops bioprocess engineering approaches for upscaling.

RESEARCH CHALLENGES

- Plants as phytofactories
- Resilient and sustainable agriculture
- Upcycling
- Bioprospecting (genetic diversity screening, -omics)
- Plant cell suspension culture
- Characterization and quantification of bioactive compounds
- Plant synthetic biology

APPLICATION AREAS

- Cosmetics
- Bio-stimulants
- Bio-control
- Biopesticides
- Sustainable agriculture
- Nutraceuticals
- Food industry

MAIN ASSETS

- Innovative high-value cosmetic products from plants and plant cells - [INNOCELLS](#)
- Upscaling And Validation Of A Technology Aiming To Produce An Apple Cell Suspension Culture-based Cosmetics Ingredient - [ACCDEE](#)
- Production of Interpenes Extract From Apples Cells - [IPSAE](#)
- Production of nutritional supplements using green extraction methods for the upcycling of brewery residues - [BIOFIT](#)
- Production Of High Added Value Phenolics In Cannabis Sativa Via Salinity Eustress: Focus On Plants And Cell Cultures - [HEMPHASE](#)
- Dicarboxylic Acid Synthesis Elucidation - [DANTE](#)
- Functionalized Silicon particles application to boost phyto-resilience - [CAPHYLOE](#)
- Studying cell wall-associated processes in fibres of nettle - [CELLWALLNET](#)
- Impact of cadmium and zinc on fiber production in hemp (Cannabis sativa): an integrated approach assessing the protective effect of silicon - [HEMPFI](#)

EQUIPMENT

- Bioreactors (0.5 L-300 L, stirred- and wave-tank, with and without illumination)
- Bioreactor for solid state fermentation
- Plant tissue culture facility
- Plant growth chambers
- Plant transformation facility (gene gun, electroporator, qPCR and PCR machines, automated dispensing system for 384 well plates, gel electrophoresis chambers, Bioanalyzer, NanoPhotometer, vacuum infiltration system)
- Ball grinder
- Laboratory blender
- Fluorescence microscope and stereo microscope
- Phenotyping station
- Microtome/vibratome/cryomicrotome
- Microplate reader
- Ultrasonic bath
- Freeze dryer
- CCD camera
- Turbovap® evaporator
- Ultracentrifugal Mill
- Pilot plant for extraction
- Rotary evaporator
- Vacuum oven
- Table-top Homogenizer
- Table-top vacuum packing machine
- High pressure homogeniser
- Oscillatory reometer
- 3D printer
- Ultrasound processor

SELECTED PUBLICATIONS

- [Phyto courier, a silicon particle-based nanophotostimulant: evidence from Cannabis sativa exposed to salinity](#), Guerrero G., María Sotero F., et al. 2021. ACS Nano 15, 3061-3069
- [Impact of cadmium and zinc on proteins and cell wall-related gene expression in young stems of hemp \(Cannabis sativa L.\) and influence of exogenous silicon](#), Luyckx M., Hausman J.-F., et al. 2021. Environmental and Experimental Botany, 183, 104363.
- [Molecular insights into plant desiccation tolerance: transcriptomics, metabolomics and targeted metabolite profiles in Cratogeomys palmetum](#), Xu X., Legay S., et al. 2021. The Plant Journal.
- [A Molecular Blueprint of Lipin Biosynthesis](#), Behr M., Guerrero G., et al. 2019. Trends in Plant Science, 24, 1052-1064.
- [Cell wall composition and transcriptomics in stem tissues of stinging nettle \(Urtica dioica L.\): spotlight on a neglected fibre crop](#), Xu X., Backes A., et al. 2019. Plant Direct, 3, 1-17.
- [Cannabis sativa: The plant of the thousand and one molecules](#), Andre, C.M., Hausman, J.-F., et al. 2016. Frontiers in Plant Science 7, 19.
- [A Molecular Blueprint of Lipin Biosynthesis](#), Behr M., Guerrero G., et al. 2019. Scientific Reports 7, 4961.
- [Cytotoxic gel-forming capacity of alfalfa \(Medicago sativa L.\) and fenugreek \(Trigonella foenum-graecum\) seed galactomannans](#), Hellebois, T., Gaiani, C., Fortuin, J., Shaplov, A., & Soukoulis, C. 2021. Carbohydrate Polymers, 267, 118190.
- [Structure, conformation and rheology of characterisation of alfalfa seed \(Medicago sativa L.\) galactomannans](#), Hellebois, T., Soukoulis, C., Xu, X., Hausman, J.-F., Shaplov, A., Tsoulis, P. S., & Gaiani, C. 2021. Carbohydrate Polymers, 256, 117394.
- [A comprehensive overview on the main and nanotechnological innovations advances for enhancing the chemical stability and bioavailability of carotenoids](#), Soukoulis, C., & Bohn, T. 2018. Critical Reviews in Food Science and Nutrition, 58(1), 1-36.
- [Plant seed mucilage as emerging biopolymer in food industry applications](#), Soukoulis, C., Gaiani, C., & Hoffmann, L. 2018. Current Opinion in Food Science, 22, 28-42.

Partners

- PM International (LU)
- Sisaf Ltd. (UK)
- Université catholique de Louvain (BE)
- University of Liège Gembloux Agro-Bio Tech (BE)
- VIT (BE)
- Hasselt University (BE)
- Free University of Berlin (DE)

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