

Molecular and Genetic Analysis of Glucosinolate Defence Systems and Their Effect on Plant Root-Microbe Interactions

In nature, various organisms live together and interact with each other; sometimes they fight, and sometimes they cooperate. Organisms frequently use chemicals as a communication tool. Plants can produce numerous species-specific chemicals and use them as a message for other organisms like famous floral scents are attractants of insects. Another example would be the usage of repelling chemicals that give plants unpleasant smell or taste to defend themselves from animals.

Plants of the cabbage family (Brassicaceae) produce mustard oil to protect themselves from herbivore attacks. Mustard oil is composed of chemicals called isothiocyanates, which give a characteristic spicy smell and taste of Brassicaceae plants. These plants accumulate inactive precursor forms of isothiocyanates, and activate the chemicals by the enzyme reaction on demand when plants receive damage by an animal chewing.

Recent findings revealed that isothiocyanates are not only crucial for the protection from herbivores but are also involved in the defence against fungal and bacterial pathogens. Plant roots are continuously exposed to fungi and bacteria in the soil; Some of these microorganisms are cooperative, but some are pathogenic to plants. The cooperative or pathogenic interactions between plants and microorganisms might be species-specific. For example, Brassicaceae plants do not cooperate with arbuscular mycorrhizae, which usually infects most of the other plant species and provide them with minerals. Therefore, Brassicaceae plants may foster different types of microbial communities in their roots, and the chemical defence mechanism underlies the differences. The analysis of the impact of mustard oil on root microorganisms remained challenging because the exact cellular system to generate isothiocyanates was still unclear for the roots.

Our research group has recently found that Brassicaceae-specific subcellular compartments, named ER bodies, accumulate the enzymes activating glucosinolates. Since ER bodies are the major vessels of the enzymes in the roots, one can expect that the majority of isothiocyanates is produced by ER bodies. Besides of ER bodies, there are additional enzyme vessels, but their contribution to root microbiota community is unknown. Therefore, the project scopes how the Brassicaceae plants establish a mustard-oil-dependent root microbial community by using an experimental model organism *Arabidopsis thaliana*. In the project, we will explore the microbial community shift in the wild type and gene knockout plants with disarmed mustard oil defence system. We will investigate the detailed interaction of plants and microorganisms at the cellular and subcellular level. The findings from the project will increase our knowledge of chemical communication between plants and microorganisms and will also uncover eco-physiological roles of plant defence chemicals. This may further open the possibility of an agricultural application like a smart way of disease less organic farming since Brassicaceae includes many vegetables.