Systems Biology of Carnivorous Plants: From Fundamental, Applied to Translational

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Background

Carnivorous plants are Darwin's most wonderful plants that evolved unique trapping and digestive mechanisms to sequester nutrients from insect preys to thrive in nitrogen-poor habitats. Their elaborate traps have fascinated many botanical carnivory enthusiasts and inspired different biomimetic applications. There are many bioinspired innovations in material science, from the super sticky sundew adhesives that inspired nanomaterials for tissue engineering, to the omniphobic coating for medical devices mimicking the slippery waxy inner surface of pitchers. In biotechnology, the potential of bioengineering carnivorous plants as bioreactors for secreted plant-made proteins has been explored. Despite its proof-of-concept feasibility[1], upscaling of this expression system is hindered by challenging genetic transformation, low yields, and co-occurrence of proteases that hydrolyses the recombinant proteins. Previous studies mostly focused on protein profiling and the influence of stimuli on the active secretion of digestive enzymes via chitin/insect/ammonium induction experiments[2].

Methods

Recently, the carnivorous tropical pitcher plants (*Nepenthes* sp.) have been extensively studied to understand the regulation of endogenous protein secretion, replenishment, and protease activity during early pitcher opening[3-5]. Furthermore, studies using proteomics informed by transcriptomics[6] and metabolomics[7] approaches have been conducted to explore the molecular expression of proteins and metabolites in species with different dietary habits and to investigate the effects of plant hybridization.

Results

Endogenous protease activity was found to be maintained by the replenishment of certain hydrolytic enzymes, which are continuously secreted in the absence of prey; whereas other proteins are not replenished in case of protein loss. Apart from biological insights on plant protein secretion, these multi-omics bioprospecting studies also discovered many commercially useful enzymes and biomolecules with medicinal properties to be further characterized.

Conclusion

Current efforts in the characterization and bioengineering of functional probiotics for human wellbeing based on the hydrolytic enzymes discovered from these studies will be presented in this talk.

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