How a fungus integrates glucose sensing with carbon catabolite repression and development to adapt to living plants versus decaying litter

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Purpose: The natural habitat of fungi is a complex environment, where appropriate interaction with other microbes, but also with plants is crucial for successful colonization and propagation. While considerable research was done on bilateral interactions, only little is known on sensing, recognition and priorities for the output, which we investigated here.

Methods: We applied chemotropic analyses, microscopy, plant interaction assays, secondary metabolite analysis and analysis of development.

Results: We show chemotropic growth towards glucose in a concentration dependent manner in Trichoderma reesei. This reaction is dependent on the glucose sensing G-protein coupled receptors CSG1 and CSG2 as are morphological changes during growth on a natural substrate. Additionally, the whole downstream G-protein pathway as well as adenylate cyclase and protein kinase A are required for glucose induced chemotropic growth. Constitutive activation of G-protein alpha subunits abolishes concentration sensitivity.

In the absence of carbon catabolite repression, chemotropic sensing is shifted to higher concentrations, indicating that the concentration dependence reflects an adaptation to typical amounts of glucose released from decaying plant material. Thereby, T. reesei prioritizes some signals over others. Deletion of CSG1 and CSG2 abolishes chemotropic sensing of a plant and the ability to efficiently colonize living plant roots. As in Fusarium oxysporum, T. reesei senses plants using its pheromone receptors. Accordingly, sexual development is slightly enhanced in the presence of a plant and fruiting bodies are formed on top and around plant roots. The fruiting bodies clearly react to the plant roots and interact with plant tissue.

Conclusions: We conclude that sensing of a specific glucose concentration is rated for relevance and applied for regulation of enzyme production relevant for plant interaction or litter degradation.