Structural and metabolic dynamics of plant cells in context of heat acclimation

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Background incl. aims
In order to survive sub-lethal heat stress, plants possess the ability to acclimate to moderately elevated temperature. They are altering their physiology in many different ways to maintain cellular homeostasis despite the change in environmental conditions. The carbohydrate metabolism is important for energy storage and biomass production and is also involved in regulation of heat acclimation response. To accurately resolve subcellular metabolic fluxes and compartment specific metabolite concentrations in the model organism Arabidopsis thaliana, it is necessary to combine ultrastructural and metabolic data.

Methods
A non-aqueous fractionation procedure to determine subcellular metabolite concentrations was combined with 3D imaging of leaf tissue by serial block-face scanning electron microscopy, which resulted in two datasets of control and heat treated samples.

Results
We were able to generate a dataset of subcellular volumes of A. thaliana leaf tissue. This allowed us to calculate effective metabolite concentrations in three compartments of the cell, namely cytosol, vacuole and chloroplasts. Applying a kinetic model of carbohydrate metabolism, subcellular fluxes were estimated which revealed metabolic heat acclimation strategies of plant metabolism and provide evidence for a tightly regulated metabolic network.
Conclusion
The combination of microscopic techniques with metabolic and photosynthetic measurements allows a more holistic interpretation of plant heat acclimation and can help preventing misinterpretation of the individual datasets.

Keywords:

heat acclimation arabidopsis carbohydrates SBF-SEM

Reference:

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