

The adventures of an uppity mitochondrial uncoupling protein in plant energy metabolism

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Abstract

Tobacco plants overexpressing a mitochondrial uncoupling protein (p07 lines) accumulate alanine, fumarate and lactate, their mitochondria have a donut-like shape and genes involved in fermentation are up-regulated. This suggests that p07 plants are shifting from aerobic to anaerobic metabolism, which explains why those plants have a greater rate of carbon assimilation than WT plants. Contrasting, p07 plants have a down-regulation of genes encoding subunits of photosystems.

UCP, mitochondrion, chloroplast.

Introduction

UCP is a mitochondrial uncoupling protein that stimulates the electron transport chain by constantly dissipating the proton gradient across the inner mitochondrial membrane, which decreases the rate of ROS production. Plants overexpressing the UCP1 gene (p07 lines) have shown significant changes in the expression of genes encoding proteins from several different pathways in the cell, including genes that affect chloroplast metabolism. We have found by metabolite quantification that those plants seem to accumulate lactate, alanine and fumarate, which are metabolites known for being present during hypoxic stress, when plants use the fermentative pathway rather than aerobic respiration to supply the demand for energy. Furthermore, mitochondria from p07 plants have a donut-like shape, which are characteristic of mammal tissues under hypoxic stress.

Results and Discussion

A real-time PCR analysis has shown that p07 plants under normal conditions up-regulate genes from the fermentative pathway just as plants under hypoxia do. We have found that p07 plants are down-regulating photosystems subunits-encoding genes. Nevertheless, they also have a greater amount of chlorophyll content, which probably allows the cells to reach homeostasis again and have the same photosynthesis efficiency of WT plants, as we have found by fluorescence quantification of leaf samples.

Conclusions

P07 plants seem to be shifting from aerobic to anaerobic metabolism, which might explain why those plants have a greater rate of carbon assimilation. However, it's still unclear how they maintain same photosynthesis efficiency of wild type plants.

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