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Chloroplast acetyltransferases in regulation of photosynthesis

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Acetylation is one of the most common chemical modifications affecting a variety of molecules ranging from metabolites to proteins. Recent development of enrichment techniques and mass spectrometry has revealed that acetylation is a prevalent modification also in plants, and that in addition to cytosolic and nuclear proteins also numerous chloroplast proteins are acetylated. We have characterized a chloroplasts-localized family of GNAT acetyltransferases in Arabidopsis thaliana. GNAT enzymes are unique among acetyltransferase enzymes as they possess dual protein acetylation activity, i.e. they catalyze both N-terminal and lysine acetylation. Our results show that each GNAT enzyme has distinct specificity in terms of favored substrates, and that they play unique roles in the accumulation of metabolites, e.g. ascorbate and oxylipins. Depletion of GNAT2 has marked effects on the acetylation level of several chloroplast proteins and on photosynthetic properties of plants. Specifically, formation of the Photosystem I-LHCII complex is prevented in the gnat2 knock-out plants, which results in impaired balancing of the light energy between the photosystems (state transitions). Moreover, loss of GNAT2 severely disturbs light-dependent dynamics of thylakoid stacking. Altogether, our results indicate that chloroplast acetyltransferases are new and important regulators of photosynthetic light harvesting with a marked impact on the metabolism of plants.

References: Koskela et al. 2018 Plant Cell 30 ; Koskela et al. 2020 Photosynth Res 145-; Bienvenut et al. 2020 Mol Syst Biol 16; Rantala et al. 2022 Plant Cell Physiol 63; Ivanauskaite et al. 2023 Plant Cell Physiol 64.

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