

Transporters for Caffeyl Alcohol Uptake During C-lignin Biosynthesis

Background

- The mode of transport of lignin monomers to the sites of polymerization in the apoplast of plant cell walls remains controversial.
- C-lignin is a recently discovered form of lignin found in the seed coat of *Cleome hassleriana* that is composed exclusively of caffeyl alcohol. It has potential for conversion to chemicals and biomaterials.

Approach

- RNAseq and proteome analysis were used to identify transporters with expression kinetics paralleling the formation of C-lignin in the *Cleome* seed coat.
- Expression of cloned transporters in yeast cells and in membrane vesicles was coupled with influx/efflux analysis to determine transporter specificity and kinetics.
- Transporters were expressed in *Arabidopsis* and alfalfa to determine activity *in planta*.

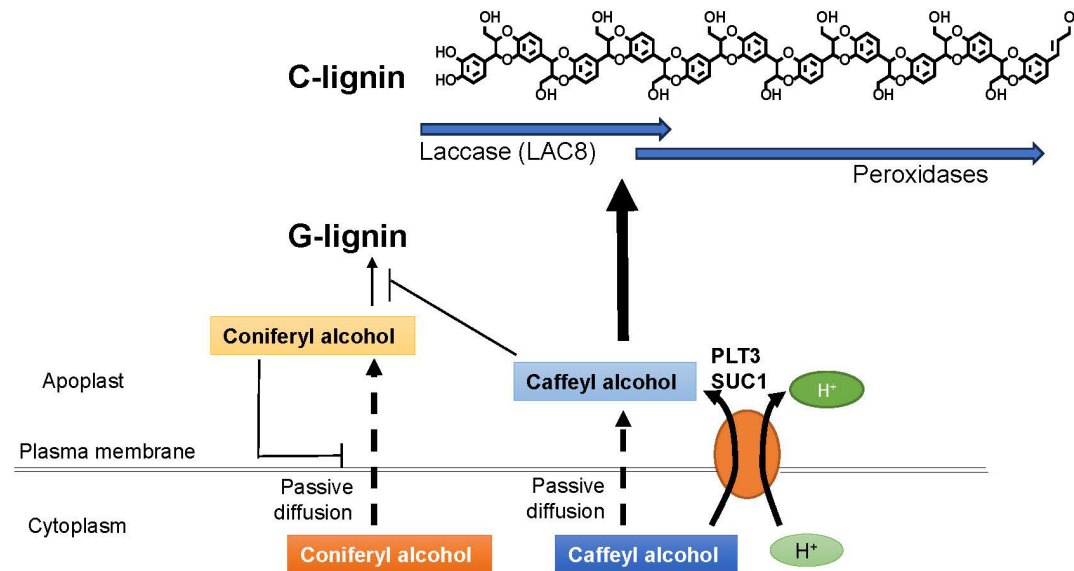
Results

- Transporters were identified that co-expressed with C-lignin deposition in the seed coat of *Cleome hassleriana*. Two low affinity transporters, ChPLT3 and ChSUC1, transport caffeyl alcohol but not the standard monolignols (*p*-coumaryl, coniferyl or sinapyl alcohols); this was consistent with modeling and docking studies.
- Expression of ChPLT3 in *Arabidopsis* seedlings enhanced root growth in the presence of caffeyl alcohol and expression of ChPLT3 or ChSUC1 correlated with lignin C-unit content in hairy roots of *Medicago truncatula*. (alfalfa).

Significance

- Passive caffeyl alcohol transport may be supplemented by hitchhiking on secondary active transporters to ensure synthesis of C-lignin in the apoplast.
- Our study suggests that, at least in the seed coat, there may be no transporters for the monolignols leading to H, G or S units of lignin.
- It appears unlikely that there is a single conserved mechanism for monolignol transport in plants and active transport may be monolignol specific.

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A hypothetical model for the facilitated diffusion of caffeyl alcohol in the seed coat of *Cleome*.