
 ABSTRACTS (MASTER THESIS)

Functional characterization of *p*-coumaroyl-CoA:monolignol transferase genes involved in lignin biosynthesis in rice

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Abstract

Among the variety of biomass feedstocks under consideration for biorefinery, grass biomass crops, such as *Erianthus*, sorghum, switchgrass and bamboo, have attracted considerable attention especially because of their superior biomass productivities. It is thus becoming increasingly important to facilitate our understanding of the biosynthesis, structures, and properties of grass lignocellulose to optimize their production and properties for biorefinery applications.

Lignin is a complex aromatic polymer produced in plant cell walls and accounts for 15-30% by weight of lignocellulose. Grass lignins have unique structural features that are prominently different from eudicot and gymnosperm lignins. One of the distinguishing features is the partial attachment of *p*-coumarates (*p*CAs) on the γ -positions of the phenylpropanoid sidechains. Such lignin γ -coumaroylation arises from the incorporation of monolignol-*p*CA conjugates which may be generated by *p*-coumaroyl-CoA:monolignol transferase, PMT, a member of the BAHD (BEAT, AHCT, HCBT, and DAT) acyltransferase (AT) family [1,2]. Currently, the physiological function of *p*-coumaroylated lignins in grass cell walls remains poorly understood. In addition, it is yet largely unknown how such lignin *p*-coumaroylation affects the biomass utilization properties of grass lignocellulose.

In this thesis, the author attempted to identify rice PMTs responsible for lignification in rice, and also to obtain novel *PMT*-deficient rice mutants that could be useful to study the elusive functions and properties of *p*-coumaroylated lignins. To these ends, the author first conducted genetic and biochemical characterizations of rice BAHD AT proteins and identified one new putative PMT, i.e., OsAT3, in addition to the previously identified OsAT4 [1]. The author demonstrated that both OsAT3 and OsAT4 show *in vitro* PMT activity to convert monolignols into the corresponding monolignol-*p*CA conjugates. Accordingly, by using the CRISPR/Cas9 genome editing system, the author successfully generated rice mutants deficient either in *OsAT3* or in *OsAT4*, and demonstrated, through in-depth structural analyses using 2D NMR, that both of the mutants produced altered lignins with decreased *p*CA levels. Collectively, these results establish the *in planta* functions of OsAT3 and OsAT4 as PMTs to generate *p*-coumaroylated lignins in rice cell walls. Further comprehensive analyses of the *PMT*-deficient mutants developed in this study should facilitate our understanding of the elusive physiological role of *p*-coumaroylated lignins in grass cell walls. Besides, various physical and chemical properties as well as biomass utilization properties of the lignin-modified modified lignocellulose are worthy of further investigation.

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References

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