Lytic polysaccharide monooxygenases (LPMOs) are important for the enzymatic conversion of biomass and seem to play a key role in degradation of the plant cell wall. In this study, we characterize an LPMO from the fungal plant pathogen *Fusarium graminearum* (FgLPMO9A) that catalyzes the mixed C1/C4 oxidative cleavage of cellulose and xyloglucan, but is inactive towards other (1,4)-linked β-glucans. Our findings indicate that FgLPMO9A has unprecedented broad specificity on xyloglucan, cleaving any glycosidic bond in the β-glucan main chain, regardless of xylosyl substitutions. Interestingly, we found that when incubated with a mixture of xyloglucan and cellulose, FgLPMO9A efficiently attacks the xyloglucan, whereas cellulose conversion is inhibited. This suggests that removal of hemicellulose may be the true function of this LPMO during biomass conversion.
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