Loosening Xyloglucan for The Enzymatic Degradation of Cellulose in Wood

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Ethanol produced from crop plants has become a major supplement to fossil fuels for transportation. However, current industrial raw materials for bioethanol compete with food. Therefore, lignocellulose is considered to be an important potential feedstock because cellulose is the most abundant organic compound on earth. Furthermore, the use of plant cell walls as a major energy resource could help mitigate global warming problems since the walls constitute natural CO_2 sinks. However, they are very resistant to enzymatic degradation and thus difficult to degrade into fermentable sugars. It is now necessary to achieve a transformational modification of wood which will enable its use not only as a material but also as a source of glucose through genetic engineering techniques that lead to an increase in polysaccharide digestion.

In order to create trees in which cellulose can be enzymatically hydrolyzed for complete saccharification, we examined several transgenic poplars, each overexpressing xyloglucanase, cellulase, xylanase, or galactanase. The level of cellulose degradation achieved by a cellulase preparation was markedly greater in the xylem overexpressing xyloglucanase and greater in the xylems overexpressing xylanase or cellulase than in the xylem of the wild-type plant. Although a high degree of degradation occurred in all xylems at all loci, the crystalline region of the cellulose microfibrils was highly degraded in the xylem overexpressing xyloglucanase. Since the complex between microfibrils and xyloglucans may be a region that is particularly resistant to cellulose degradation, loosening xyloglucan may facilitate the enzymatic hydrolysis of cellulose in wood.