# ENZYMATIC BIOMASS UTILIZATION AND MODIFICATION

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Environmental concerns, the requirements for energy and carbon efficiency as well as the need to reduce dependency on fossil feedstocks lead to a necessity to develop new bio-based processes and products that support sustainable development and create novel possibilities to boost Bioeconomy. Lignocellulosic biomass mainly composed of cellulose, hemicellulose and lignin is a renewable, abundant non-food starting material for various applications. Cellulases and related enzymes have for decades attracted substantial interest in various industrial applications. For the total hydrolysis of biomass to produce biofuels and other chemicals, mixtures of different (hemi)cellulolytic enzymes have been used, composed of cellobiohydrolases, endoglucanases, β-glucosidases, hemicellulases and helper activities that act in a synergistic manner. On the other hand, for the fibre-based applications usually tailored, or monocomponent enzyme preparations have been applied. The exact composition and proportions of the different enzymes depends in each case on the raw material used, and also on the biorefinery concept to be applied.

Despite of the vast development of the lignocellulolytic enzymes, more efficient enzymes and enzyme cocktails are still needed. At VTT, novel cellulolytic enzymes have been discovered from environmental samples, culture collections, metagenomic libraries and genomic databases. Enzyme properties have also been improved by protein engineering. We have also analyzed the limiting factors in the hydrolysis, especially the role of hemicellulose and lignin. Molecular level mechanistic studies have paved way for development of more efficient enzymes. Besides biomass degradation, enzymes have been applied for fibre modification. Furthermore, protease deletion strains and strains with modified cellulase regulation pathways have made it possible to substantially increase protein production in *Trichoderma reesei,* the industrial production host.

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