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Vincent Eijsink.

Bioenergy Innovation Award 2015 to Vincent Eijsink

NMBU's Professor Vincent Eijsink recently received the 2015 Bioenergy Innovation Award for his contributions to the development of bioenergy technologies in Norway. The Award Committee cited not only his research accomplishments but also his willingness to work together with industry.

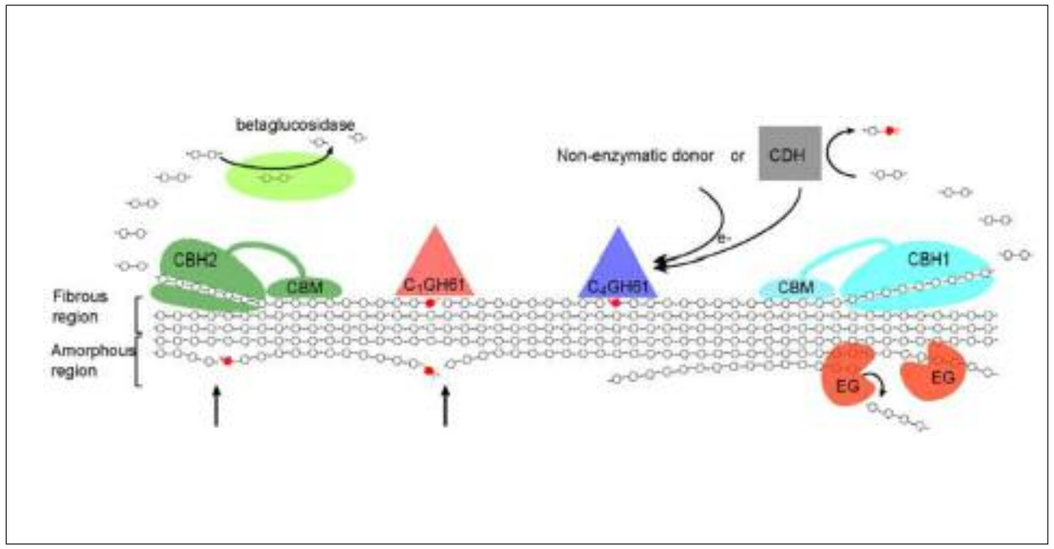

Figure 1. Current view of fungal degradation of cellulose by enzymes. Abbreviations: EG, endoglucanase; CBH, cellobiohydrolase, CDH, cellobiose-dehydrogenase; CBM, carbohydrate-binding module. Many cellulolytic enzyme systems have multiple EGs and/or CBHs that may act on various parts of the substrate. The Figure shows a C1 and a C4 oxidizing GH61 (LPMO) which would generate optimal ends for the CBH2 and CBH1, respectively (oxidized sugars are colored red). Combined action of C1 and C4 oxidizing enzymes may produce native cello-oligosaccharides from the middle of the cellulose chain. The possible consequence of GH61 action is illustrated in the lower part of the Figure, where new attacking points for CBHs are indicated by arrows.

It is estimated that photosynthesis worldwide captures about 15 TW hours (terrawatt hours) of energy as biomass every year. This number, if it could be fully exploited, represents approximately 10% of total energy consumption yearly from all sources, including hydroelectric, natural gas, oil, coal and nuclear. As a renewable energy source, biomass has advantages both environmentally and politically compared to non-renewable energy sources such as oil, natural gas and coal. On the other hand, because biomass consists to a large extent of lignocellulosic material, a major challenge of bioenergy research directed towards biomass involves the development of methods to release individual glucose components of lignocellulose. Even though enzymes degrading lignocellulose (cellulases) were identified and purified from fungi more than 60 years ago, these primarily endolytic enzymes act slowly on crystalline cellulose microfibrils which consist of cellulose chains that are so tightly packed together that even individual water molecules are excluded. Degradation of chitin, which is the major component of shrimp, lobster and crab shells, presents a similar challenge even though its building block involves N-acetylglucosamine subunits.

Based on possibilities for funding, Eijsink and his colleagues began their bioenergy research, focusing on chitin and chitinases. In 2005, they published an important paper (1), describing a chitin-binding protein (CBP21) from Serratia marcescens that strongly promotes chitin degradation by chitinases. In 2010, the NMBU group published a Science paper (2), showing that CBP21 oxidatively cleaves glycosidic bonds in chitin, generating a non-reducing chain end and a chain end terminated by C1-oxidized aldonic acid. This important paper also showed that CBP21 activity can be boosted by addition of electron donors such as ascorbic acid and that the enzyme reaction depends on divalent metal ions.

Subsequent work at NMBU and internationally has identified CBP21-like enzymes from various sources, acting as copper-dependent monooxygenases and facilitating degradation of both chitin or cellulose (3). The general term lytic polysaccharide monooxygenase (LPMO) is applied to these enzymes. Today, Vincent Eijsink and his colleagues are working actively with industry partners in Norway and elsewhere to optimize conditions for biomass degradation. Figure 1 shows their model for lignocellulose degradation based on modern thinking (4).

References

1. Vaaje-Kolstad et al.: J. Biol. Chem. 280 (2005) 28492.
2. Vaaje-Kolstad et al.: Science 330 (2010) 219.
3. Forsberg et al.: Prot. Science 20 (2011) 1479.
4. Horn et al.: Biotechnology for Biofuels 5 (2012) 45.