Feruloyl esterases: a tool for biotransformation of hemicellulose to bioactive compounds

Cyrielle Bonzom, Christian Thörn, George Anasontzis, Laura Schild and Lisbeth Olsson
Department of Biology and Biological Engineering, Industrial Biotechnology, Chalmers University of Technology, Kemivägen 10, SE-412 96 Gothenburg, Sweden
cyrielle.bonzom@chalmers.se

FAEs can be used to hydrolyze ferulic acid (FA) from lignocellulosic biomass, therefore helping in its depolymerization, but also in modifying FA and other hydroxycinnamic acids to produce bioactive compounds through transesterification and esterification reactions.

Lignocellulose and ferulic acid

Ferulic acid is found mostly as a substituent of hemicellulose polymers. It has also been shown that diferulic acid cross linking can happen between lignin and hemicellulose [1].

Some reactions catalyzed by FAEs

FAEs can catalyze different reactions: (A) Transesterification of MFA with 1-butanol generating BFA and methanol. (B) Hydrolysis of MFA generating ferulic acid and methanol (natural reaction at high water contents). (C) Esterification of FA with 1-butanol generating BFA and water [4].

Feruloyl esterases (FAEs)

They are a class of enzymes active on ester bounds and release FA and other hydroxycinnamic acids. They are therefore part of the hemicellulose group and classified under the Cazy family CE1.

Apart from their natural hydrolytic reaction, they can also catalyze esterification and transesterification reactions.

Properties of hydroxycinnamic acids

The most known and studied of the hydroxycinnamic acids (HCA) is ferulic acid.

- Antioxidant
- Antibacterial
- Anticancer
- Anti hypertensive
- Approved as food additive (USA, Korea, Japan) [2]

Other HCAs have been found to also have antioxidant properties [3].

FA is hydrophilic. Making it more lipophilic can be done by esterification or transesterification with FAEs.

Immobilization and mesoporous silica materials

Why immobilizing?
- Reusability
- Stability
- Selectivity
- Downstream purification

Why MPS?
- Adsorption
- Reduces leakage
- Tunable
- Stable

Selectivity ratio between transesterification and hydrolysis changes upon immobilization [4]
Immobilization in SBA-15 yields good operational stability and reusability [4]
Immobilization yields and the following enzymatic reactions are pH dependent [5]
Methodology to measure pH inside the pores [6]
Methodology to follow immobilization in real time [7]
Km unchanged upon immobilization [8]

Future research

✓ Effects of ionic liquids on transesterification with immobilized FAEs
✓ Effects of glycosylation on immobilization
✓ Effects of support surface modifications