Kinetic study of activation and deactivation of adsorbed cellulase during enzymatic conversion of alkaline peroxide oxidation-pretreated corn cob to sugar

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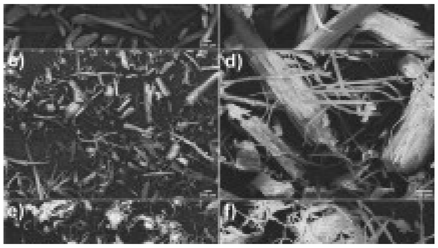
Abstract

Corn cob lignocellulosic biomass is one of the useful precursors for the alternative production of fuels and chemicals. Understanding the kinetics of enzymatic conversion of corn cob through kinetic models could provide indepth knowledge and increase the predictive ability for process design and optimization. In this study, models based on the semi-mechanistic rate equations, first-order decay exponential function of time for adsorbed enzymes, structural and diffusion coefficient for adsorption were used to estimate kinetic parameters for the enzymatic conversion of alkaline peroxide oxidation (APO) pretreated corn cob to sugar. Fitting a first-order inactivation model of adsorbed cellulases to account for experimental hydrolysis data, the apparent hydrolysis rate constant (k_2=29.51 min^{-1}), the inactivation rate constant (k_3=0.269 min^{-1}), and reactivation rate constant (k_4=0.0048 min^{-1}) were estimated. Regressed values of apparent maximum rate, $V_{max, app}$, for adsorbed enzymes reduced appreciably with time to more than 98% at 96 h. The diffusion limit model showed that the diffusion resistance increased with increasing enzyme concentrations.



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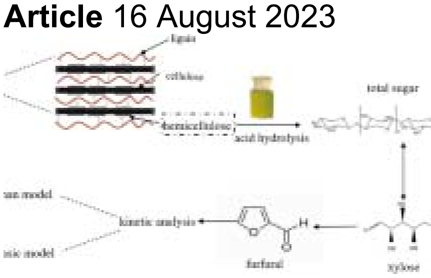

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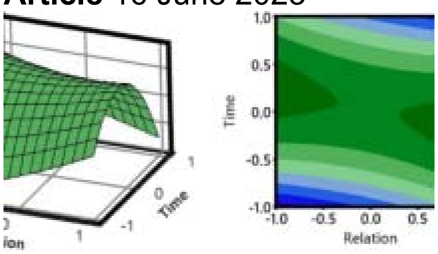

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Abbreviations

***A_o* :**

inactivation extent

***E_o* :**

initial enzyme concentration [$g \cdot L^{-1}$]

***$[E]_{total}$* :**

total enzyme concentration [$mmole \cdot L^{-1}$]

***V_o* :**

initial hydrolysis rate [mmole·$L^{-1}min^{-1}$]

***Z_o* :**

residual enzyme activity

***V_{max}* :**

maximum initial hydrolysis rate [mmole·$L^{-1}min^{-1}$]

***$V_{max,app}$* :**

apparent maximum initial hydrolysis rate [mmole·$L^{-1}min^{-1}$]

***V_r* :**

real hydrolysis rate [mmole·$L^{-1}min^{-1}$]

***$t_{1/2}$* :**

half-life [min]

***P*:**

product concentration [g·L^{-1}]

***P_σ* :**

products that diffused at equilibrium [g·L^{-1}]

***S*:**

substrate concentration [g·L^{-1}]

***k*:**

diffusion coefficient for adsorption [g·L^{-1}·h^{-1}]

***k_m* :**

half-maximum initial hydrolysis rate [g·L^{-1}]

***k_2* :**

apparent hydrolysis rate constant [min^{-1}]

***k_3* :**

inactivation rate constant [min^{-1}]

***k_4* :**

reactivation rate constant [min^{-1}]

***n*:**

structural diffusion resistance constant

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Electronic supplementary material

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