Ultrasound mediated enzymatic hydrolysis of cellulose and carboxymethyl cellulose

Ahmad Ziad Sulaiman[a], *Azilah Ajit*[a], *Yusuf Chisti*[b]
[a] Faculty of Chemical Engineering and Natural Resources, Universiti Malaysia Pahang, Lebuhraya Tun Razak, 26300 Kuantan, Pahang, Malaysia
[b] School of Engineering, Massey University, Private Bag 11 222, Palmerston North, New Zealand

ABSTRACT
A recombinant *Trichoderma reesei* cellulase was used for the ultrasound-mediated hydrolysis of soluble carboxymethyl cellulose (CMC) and insoluble cellulose of various particle sizes. The hydrolysis was carried out at low intensity sonication (2.4–11.8 W cm^{-2} sonication power at the tip of the sonotrode) using 10, 20, and 40% duty cycles. [A duty cycle of 10%, for example, was obtained by sonicating for 1 s followed by a rest period (no sonication) of 9 s.] The reaction pH and temperature were always 4.8 and 50°C, respectively. In all cases, sonication enhanced the rate of hydrolysis relative to nonsonicated controls. The hydrolysis of CMC was characterized by Michaelis-Menten kinetics. The Michaelis-Menten parameter of the maximum reaction rate V_{max} was enhanced by sonication relative to controls, but the value of the saturation constant K_m was reduced. The optimal sonication conditions were found to be a 10% duty cycle and a power intensity of 11.8 W cm^{-2}. Under these conditions, the maximum rate of hydrolysis of soluble CMC was nearly double relative to control. In the hydrolysis of cellulose, an increasing particle size reduced the rate of hydrolysis. At any fixed particle size, sonication at a 10% duty cycle and 11.8 W cm^{-2} power intensity improved the rate of hydrolysis relative to control. Under the above mentioned optimal sonication conditions, the enzyme lost about 20% of its initial activity in 20 min. Sonication was useful in accelerating the enzyme catalyzed saccharification of cellulose.

KEYWORDS
Carboxymethyl cellulose; Cellulase; Cellulose hydrolysis; Enzymatic hydrolysis; Ultrasound

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