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Fermentation of Pretreated Herbaceous Cellulosic Wastes to Ethanol by Anaerobic Cellulolytic and Saccharolytic Thermophilic Clostridia

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Abstract : Lignocellulosic waste streams from agriculture, paper and wood industry are renewable, plentiful and low-cost raw materials that can be used for large-scale production of liquid and gaseous biofuels. As opposed to prevailing multi-stage biotechnological processes developed for bioconversion of cellulosic substrates to ethanol where high-cost cellulase preparations are used, Consolidated Bioprocessing (CBP) offers to accomplish cellulose and xylan hydrolysis followed by fermentation of both C6 and C5 sugars to ethanol in a single-stage process. Syntrophic microbial consortium comprising of anaerobic, thermophilic, cellulolytic, and saccharolytic bacteria in the genus Clostridia with improved ethanol productivity and high tolerance to fermentation end-products had been proposed for achieving CBP. 65 new strains of anaerobic thermophilic cellulolytic and saccharolytic Clostridia were isolated from different wetlands and hot springs in Georgia. Using new isolates, fermentation of mechanically pretreated wheat straw and corn stalks was done under oxygen-free nitrogen environment in thermophilic conditions (T=550C) and pH 7.1. Process duration was 120 hours. Liquid and gaseous products of fermentation were analyzed on a daily basis using Perkin-Elmer gas chromatographs with flame ionization and thermal detectors. Residual cellulose, xylan, xylose, and glucose were determined using standard methods. Cellulolytic and saccharolytic bacteria strains degraded mechanically pretreated herbaceous cellulosic wastes and fermented glucose and xylose to ethanol, acetic acid and gaseous products like hydrogen and CO2. Specifically, maximum yield of ethanol was reached at 96 h of fermentation and varied between 2.9 – 3.2 g/ 10 g of substrate. The content of acetic acid didn’t exceed 0.35 g/l. Other volatile fatty acids were detected in trace quantities.

Keywords : anaerobic bacteria, cellulosic wastes, Clostridia sp, ethanol
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