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Extremophiles in biofuel synthesis from solid wastes

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More than 34% of a typical solid waste are food, wood and yard waste whereas paper and paperboard contribute to another 25% to the ever increasing issue of waste management and its disposal. To date physiochemical pretreatment of solid wastes has been shown a necessary step for previously listed consolidated biological processes which increases the overall cost of the process e.g., plant biomass is inexpensive ($2-4/GJ at a cost of $39-60/dry ton biomass) but its pretreatment cost ($15-25/GJ) dramatically reduce the overall cost-efficiency of the process. An alternative to the bioprocess involving pretreatment is the development of an efficient and cost-effective single step process for untreated solid waste management using extremophiles. For example, thermophiles and their enzymes can play important roles in many kinds of bioprocessing including in conversion of non-food biomass into biofuels. The Homestake gold mine (8000 ft. deep, Lead, SD) offers a unique opportunity for direct exploration of the deep biosphere environment. Using soil/biofilm samples of deep biosphere of the Homestake Gold Mine, compost facility (Rapid City, SD) and Hot Springs State Park (Thermopolis WY), we have isolated several thermophilic cellulose and xylan-degrading and fermenting pure cultures belonging to the genera *Brevibacillus, Paenibacillus, Clostridium, Bacillus* and *Geobacillus*. Unique characteristics of lignocellulose-deconstructing enzymes produced by mine and compost-thermophiles include optimum temperatures of >70°C, pH ranges from 4-8 and high thermostability (e.g., at 60°C, 50% of cellulases and xylanases activities were retained in 35 and 23 days of incubation, respectively). Our thermophiles also produced biohydrogen or bioethanol in a single step bioprocessing of various inexpensive regional untreated biomass (e.g., prairie cord grass and corn stover). This talk will describe the limitations in exiting solid waste conversion technologies and possible ways to overcome those limitations using thermophiles and their enzymes. The influence of high temperatures on various existing lignocellulose conversion processes and those that are under development, including separate hydrolysis and fermentation, simultaneous saccharification and fermentation and extremophilic consolidated bioprocess will discussed. Integrated decentralized thermophilic biofuel production employing cellulolytic and fermentative thermophiles in a single step consolidated process will also be discussed.

Biography

Rajesh Sani is an Associate Professor in the Department of Chemical and Biological Engineering at South Dakota School of Mines and Technology, USA. His research includes extremophilic bioprocessing of lignocellulose-based renewable for biofuels and bioproducts and bioprospecting of extremophilic microorganisms for developing more efficient and cost-effective biofuel (bioenergy) production technologies. Over the past 10 years, he has been the PI or Co-PI on over $10.5 million in funded research. He has one patent, five invention disclosures and published 50 peer-reviewed articles in high impact factor journals and has contributed in several book chapters. In addition, he has been a proposal Reviewer and Panelist for the Federal Agencies and also serves the Industrial Microbiology profession as "Biocatalysis Program Committee Member" of the Society for Industrial Microbiology and Biotechnology (SIMB), Technical Session Chair at the Annual American Institute of Chemical Engineers (AIChE) and SIMB and is also an Associate Editor.

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