EXTRACELLULAR ELECTRON SHUTTLES IN BIOFUEL PRODUCTION

Xiaofeng Ye*
Kevin T. Finneran
University of Illinois at Urbana-Champaign
Department of Civil and Environmental Engineering
4162 Newmark Civil Engineering Lab
205 N. Mathews Avenue
Urbana, IL 61801
Voice: 217-721-3801
Fax: 217-333-6968
ye3@uiuc.edu

Hydrogen, butanol, and ethanol produced during fermentation are considered clean, sustainable energy sources or carriers. Theoretically the substrates for ABE/H2 fermentation can be diverse renewable resources, such as cellulosic waste and agricultural byproducts. However, fermentative microorganisms currently do not utilize these substrates efficiently enough to generate “marketable” yields from renewable or waste materials.

This research focuses on extracellular electron shuttles, which have been proven to stimulate the biodegradation and abiotic degradation of organic compounds, for increased hydrogen production as well as acetone, butanol and ethanol production in Clostridium beijerinckii ABE fermentation. Reduced electron shuttles (hydroquinones) were introduced to stimulate the fermentation processes. Current results demonstrated that hydrogen production increased by 30-60% before solventogenic phase in the batch experiments; and by 80% (27 µmol versus 15 µmol in the controls) in the chemostat. Hydroquinones also increased butyric acid production by more than 100%; butyric acid and butanol are generated in the same metabolic pathway, and we are investigating the influence of electron shuttles on ABE. This is a novel method of delivering excess “reducing equivalents” to fermentative cultures to increase biofuel yield. The electron shuttles are catalytic and only a low concentration is needed. We are developing co-cultures with quinone-reducing cells to continually feed hydroquinones to fermentative organisms. This strategy may “bridge the gap” between cellulosic substrates and fermentative biofuel production by linking two disparate metabolic pathways with extracellular electron shuttles.

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