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7. Title

Investigation of Technologies for the Conversion of a Sugar Mill into a Biorefinery for the Production of Ethanol, Energy and Chemicals

12. Investigator Name(s) (Last Name and Initials)

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20. Termination Date 09/30/2013	40. Period Covered (mo/da/year): 01/01/2011 TO 12/31/2011

Outputs:

Results of the work were dissemminated in five presentations at national conferences, local and regional symposia's, ACE meeting, and private sector visits, as well as, two peer-reviewed publications, and a book chapter. Findings from these studies and technologies developed for the bioconversion of energy crops into monomeric sugars available for processing into green fuels and chemicals are part of a five year grant recently awarded by USDA-NIFA-AFRI titled "A Regional Program for Production of Multiple Agricultural Feedstocks and Processing to Biofuels and Biobased Chemicals".

Outcomes/Impacts:

Water supply, carbon dioxide and land are unexploited assets at sugarcane factories and could potentially be used for the growth and processing of algae as an additional biofuel feedstock. A mild ammonia-soaking of sugarcane bagasse during storage (one month at 30 degrees C) was investigated to determine the effects on energy content and lignin removal. The fibers were found to resist spoilage over 30 days and retained most energy content (100% cellulose, 70% hemicellulose) but lost 44% of lignin. The loss of lignin is beneficial in the conversion of biomass in that it allows better access for enzymes to hydrolyze sugar polymers into monomers for eventual fermentation to fuels and value-added products. Energy cane bagasse pre-treated with dilute ammonia (DA) at 160 degrees C for 60 min (PCT/US2009/033173) resulted in 55% delignification. DA pretreatment was very effective in lignin solubilization, exhibiting a lesser effect on cellulose and hemicellulose as compared to acid pretreatment. Non-ionic surfactants helped alter the structure of lignocellulosic biomass to improve cellulose digestibility and ethanol yields. Tween 80, Tween 20, PEG 4000 or PEG 6000 was used in combination with DA for the pre-treatment of sugarcane bagasse. PEG 4000 and Tween 80 were the most effective surfactants, increasing cellulose digestibility and ethanol yield by 78% and 73%, respectively, over DA pre-treatment without the addition of surfactants. None of the surfactants caused additional loss of cellulose, but in some cases, an increase in lignin removal was observed. Pre-treatment of sorghum bagasse with DA at 130 degrees C for 1h by microwave heating resulted in 22g ethanol/100 g dry biomass, and was comparable to DA treated biomass at 160 degrees C by conventional heating. Ionic liquid (1-ethyl-3-methylimidazolium acetate)-treated energy cane bagasse resulted in significant lignin removal (32%) with slight glucan and xylan losses (9% and 14%), and exhibited a much higher cellulose and hemicellulose digestibility (87%,64%) than non-treated (6%, 3%) and water (4%, 2%)-treated energy cane bagasse, respectively. Enhanced digestibility of 1-ethyl-3-methylimidazolium acetate-treated energy cane bagasse can be attributed to delignification and possible reduction of cellulose crystallinity. Four microalgae (Synechococcus sp., Sellaphora pupula, Chlorella sorokiniana, and Scenedesmus abundans), obtained from brackish and fresh water sources within Louisiana's Southeast region, were evaluated for their potential use in the production of biodiesel. Chlorella sorokiniana demonstrated a balanced fatty acid profile based upon cetane number, oxidative stability, viscosity and low temperature. Chlorella sorokiniana was the best candidate for biodiesel productin when using CO2 under these conditions.

Publications:

Aita, G. and Kim, M. 2011. Pretreatment Technologies for the Conversion of Biomass Materials to Bioethanol. In: Sustainability of the Sugar and Sugar-Ethanol Industries. ACS Press, Available on-line, Dec 10. ISBN13: 9780841225985; eISBN: 9780841225992; DOI:10.1021/bk.

Salvi, D., Boldor, D., Aita, G. M. and Sabliov, C. M. 2011. COMSOL Multiphysics Model for Continuous Flow Microwave Heating of Liquids. J. Food Engineering 104 (3): 422-429.

Aita, G., Salvi, D., Walker, M. 2011. Enzyme hydrolysis and ethanol fermentation of alkaline pretreated energy cane. Bioresource Technol. 102 (6): 4444-4448.

Participants:

G. A. Dequeiroz (PI), Donal Day, Benjamin Legendre (Co-PI), Giovanna Aita (Co-PI), Vadim Kochergin, (Co-PI), Michelle Walker, Melati Tessier, Chardcie Verret, Lee Madsen, Shuo Cao, Zenghui Qiu, Reynaldo Moreno, Dorin Boldor, Cong Chen, LSU AgCenter. Gillian Eggleston, Barry Hulburt and Suzanne Brashear (USDA-ARS); and 11 Louisiana sugar factories along with their plant managers, and American Sugar Cane League.

Target Audiences:

Target audiences include personnel in the biofuels, bioenergy and biochemicals industries as well as sugar industry who are interested in conversion of raw sugar factories into biorefineries. Other audiences include: researchers in food science, biotechnology, biochemistry, engineering and medicine who could benefit from the findings of this project; and, the domestic sugar industry to include managers of all sugar factories in Florida, Hawaii, Louisiana and Texas and the commodity groups in these states.

Project Modifications:

Nothing significant to report during this reporting period.

Approved (Signature)	Title	Date