Hawaii Natural Energy Institute Research Highlights

Alternative Fuels

Bio Oil Extraction

OBJECTIVE AND SIGNIFICANCE: To apply ionic liquid based co-solvent mixtures for the one-step extraction of bio-oils and protein from biomass to oil-rich yeast cells. Further, to characterize the capacity of the co-solvent to both extract bio-oil and simultaneously "pretreat" the biomass such that it can be readily hydrolyzed (to simple sugars) using appropriate mixtures of hydrolytic enzymes.

BACKGROUND: Room temperature IL's remain a liquid at or near room temperature. In addition, IL's have also been shown to extract protein from aqueous two-phase systems, extract hormones from urine samples, esterify lipids, and used as a "green" solvent with biodegradable copolymers. In this work IL's were paired with polar covalent molecules (PCM) to create co-solvent systems with enhanced chemical properties that could extract and auto partition lipids from various biomass sources. This work was in contrast to traditional (i) co-solvent systems, comprised of a volatile organic solvent and a PCM, which both dissolved and extracted the bio-oil into a single phase, or (ii) the sole use of IL's as an extracting solvent.

PROJECT STATUS/RESULTS: An ionic liquid – methanol co-solvent was shown for the first time to effectively extract bio-oil and recover fermentable sugars from oil-seed biomass. In total, up to 70% (w/w) of the whole dried cell mass was recovered as lipids and fermentable sugars and the substrate to lipid yields (YP/S) was increased from 0.12 to 0.16 g lipid/g carbohydrate consumed.

The versatility of our co-solvent system was pronounced; a single solvent system was able to incorporate the properties of multiple solvents, each with their own targeted chemical activity. The result was a system that not only permitted the extraction and single step separation of multiple products, but also pretreated the biomass for further treatment to recover additional products.

This project has produced the patents and peer-reviewed papers listed on the following page.

Funding Source: Office of Naval Research APRISES

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ADDITIONAL PROJECT RELATED LINKS

PAPERS AND PROCEEDINGS:

1. 2017, S.R.P. Bandlamudi, M.J. Cooney, G.L. Martin, K.M. Benjamin, **Molecular Simulation and Experimental Characterization of Ionic-Liquid-Based Cosolvent Extraction Solvents**, Industrial & Engineering Chemistry Research, Vol. 56, Issue 11, pp. 3040-3048.
2. 2017, G. Severa, M. Edwards, M.J. Cooney, **Bio-Oil Extraction of Jatropha Curcas with Ionic Liquid Co-Solvent: Fate of Biomass Protein**, Bioresource Technology, Vol. 226, pp. 255-261.
3. 2014, G. Severa, G. Kumar, M.J. Cooney, **Corecovery of Lipids and Fermentable Sugars from Rhodosporidium Toruloides Using Ionic Liquid Cosolvents: Application of Recycle to Batch Fermentation**, Biotechnology Progress, Vol. 30, Issue 5, pp. 1239-1242.
4. 2013, G. Severa, G. Kumar, M.J. Cooney, **Corecovery of bio-oil and fermentable sugars from oil-bearing biomass**, International Journal of Chemical Engineering, Vol. 2013, Issue 2013, paper 617274.
5. 2013, M. Cooney, **Simultaneous extraction and separation of phorbol esters and bio-oil from Jatropha biomass using ionic liquid-methanol co-solvents**, Separation and Purification Technology, Vol. 116, pp. 265-270.
6. 2013, J. Yu, **Case Studies of Separation in Biorefineries—Extraction of Algae Oil from Microalgae**, in S. Ramaswamy, H-J. Huang, B.V. Ramarao (eds.) ***Separation and Purification Technologies in Biorefineries***, John Wiley & Sons, Inc., Chapter 21, pp. 533-554.
7. 2011, G. Young , F. Nippen , S. Titterbrandt , M.J. Cooney, **Direct transesterification of biomass using an ionic liquid co-solvent system**, Biofuels, Vol. 2, Issue 3, pp. 261-266.
8. 2010, G. Young, F. Nippgen, S. Titterbrandt, M.J. Cooney, **Lipid extraction from biomass using co-solvent mixtures of ionic liquids and polar covalent molecules, separation and purification technology**, Vol. 72, Issue 1, pp. 118-121.
9. 2009, M.J. Cooney, G. Young, N. Nagle, **Extraction of bio-oils from microalgae**, Separation & Purification Reviews, Vol. 38, Issue 4, pp. 291-325. (Open Access: **PDF**)

PATENTS:

1. 2013, M.J. Cooney, G.L. Young, Methods and compositions for extraction and transesterification of biomass components, US Patent 8598378.

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