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Evaluation of Subcritical Fluids for Production of 2nd Generation Bioethanol: a Step Toward Integrated Biorefinering

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Biobased economic development is the stated vision for the 21st century and as a consequence liquid transport fuels such as bioethanol, biodiesel and biobutanol have become a significant research focus. To date bioethanol is produced from starch and or sugar based feedstocks. Cellulosic ethanol, also known as second generation ethanol, is produced from cellulose (hemicellulose), which is an abundant natural polymer. However, cellulose within lignocellulosic biomass is recalcitrant to enzymatic hydrolysis in part due to the close association of lignin and hemicellulose. Several kinds of 'pretreatments' have been investigated to dissociate lignocellulosic matrix but they also generate at least four main classes of fermentation inhibitors: furfural and hydroxymethyl furfural (furans), weak acids, and phenolic compounds. Thereby, adopting the emerging concept of integrated biorefining offers the opportunity to selectively refine the natural polymers from biomass, thus supporting the recovery of hemicellulose, lignin and cellulose as polymers. Therefore an integrated biorefining approach offers the opportunity to develop multiple products from lignocellulose, adding overall value to the feedstock, and also potentially enhances overall yield of ethanol as purified cellulose fraction can be processed into glucose with hypothetically less fermentation inhibitors generation. In previous work we have demonstrated the utility of subcritical water, an environmentally benign 'green' solvent, to support the extraction of hemicellulose and lignin from *Miscanthus x giganteus*, a perennial high yielding energy crop currently being developed both in US and Europe. Subcritical water properties differ considerable from both ambient and supercritical conditions, presenting interesting advantages for lignocellulosic hydrolysis reactions. The objective of the current research is to evaluate the effect of process parameters of subcritical water mediated extraction of lignin on the level of crystallinity of cellulose fraction and how in turn this affects the efficiency of hydrolysis of the polymer to the glucose monomer using subcritical water with and without modifiers. In addition the amount of fermentation inhibitors generated during subcritical water mediated hydrolysis of purified cellulose versus the *Miscanthus* lignocellulose complex will be evaluated. The economic and process advantages and impact of using subcritical water to support the production of 2nd generation ethanol will be discussed.