ABSTRACTS (MASTER THESIS)

Microwave organosolvolysis with Lewis acid catalyst for biorefinery of sugarcane bagasse

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Global warming caused by emission of greenhouse gas by excessive use of fossil fuels, has promoted development of biofuels from renewable resources. Lignocellulosics is the most abundant renewable feedstock and it attracts considerable attention as new resources for production of biofuels and chemicals. One of the lignocellulosic materials found in great quantities, to be considered is sugarcane bagasse, although recalcitrance of the lignified plant cell wall structure is still a major limitation to utilize the plant materials. Pretreatment separating the cell wall polysaccharides, cellulose and hemicelluloses, from lignin is a crucial step to increase accessibility of polysaccharide hydrolases to their substrates prior to fermentation. In this study microwave-assisted organosovolysis with non-toxic food additive classified as Lewis acid was applied to disintegration of sugarcane bagasse for enzymatic saccharification and fermentation, and high efficiency of the process for bioethanol production was demonstrated.

Microwave pretreatment reaction of sugarcane bagasse was conducted in aqueous glycerol or 2-propanol in the presence of Lewis acid catalyst using a laboratory scale microwave reactor or a 1L microwave reactor designed for processing of biomass. After the pretreatment for 30 min, solid and liquid fractions were separated, then subjected to hydrolysis with cellulase. The reducing sugars released were determined by Somogi-Nelson method to evaluate the saccharification efficiency. Lignin content in the solid fraction was quantified. Efficiency of overall process was evaluated by separate hydrolysis and fermentation (SHF) in a test tube and simultaneous saccharification and fermentation (SSF) in a jar-fermenter using a gene-engineered ethanologenic bacterium *Zymomonas mobilis* strain capable of fermenting xylose and hexose sugars. Ethanol produced were analyzed by HPLC.

To optimize the reaction conditions, effects of 3 factors, water content, catalyst concentration and reaction temperature were evaluated in terms of the saccharification and delignification efficiency. The results showed that addition of Lewis acid in the microwave reaction considerably promoted removal of lignin from sugarcane bagasse, by 3-4 times higher efficiency than those without the catalyst. The pretreatment and enzymatic saccharification system was applied to a small scale SHF using recombinant *Z. mobilis* capable of utilizing xylose. Glucose was consumed in 24 hr with concomitant gradual decrease in xylose concentration. Bioethanol was produced in 97% of the theoretical yield. The pretreament system was scaled up to a 1L microwave reactor and SSF in a jar fermenter. The pretreatment was conducted at 180℃ in 70% glycerol with the Lewis acid catalyst at the concentration of 360 μmol/g dry biomass. After pre-hydrolysis for 48h, 78.6 g/L of glucose was released from 100 g of solid substrate, and ethanol yield reached 91% of the theoretical yield by SSF. The combination of microwave organosovolysis with Lewis acid catalyst showed promising results to utilize sugarcane bagasse as a substrate for bioethanol production toward commercial scale production.