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Optimization of Alkali Assisted Microwave Pretreatments of Sorghum Straw for Efficient Bioethanol Production

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Abstract : The limited supply and related negative environmental consequence of fossil fuels are driving researcher for finding sustainable sources of energy. Lignocellulose biomass like sorghum straw is considered as among cheap, renewable and abundantly available sources of energy. However, lignocellulose biomass conversion to bioenergy like bioethanol is hindered due to the reluctant nature of lignin in the biomass. Therefore, removal of lignin is a vital step for lignocellulose conversion to renewable energy. The aim of this study is to optimize microwave pretreatment conditions using design expert software to remove lignin and to release maximum possible polysaccharides from sorghum straw for efficient hydrolysis and fermentation process. Sodium hydroxide concentration between 0.5-1.5%, v/v, pretreatment time from 5-25 minutes and pretreatment temperature from 120-2000C were considered to depolymerize sorghum straw. The effect of pretreatment was studied by analyzing the compositional changes before and after pretreatments following renewable energy laboratory procedure. Analysis of variance (ANOVA) was used to test the significance of the model used for optimization. About 32.8%-48.27% of hemicellulose solubilization, 53% -82.62% of cellulose release, and 49.25% to 78.29% lignin solubilization were observed during microwave pretreatment. Pretreatment for 10 minutes with alkali concentration of 1.5% and temperature of 1400C released maximum cellulose and lignin. At this optimal condition, maximum of 82.62% of cellulose release and 78.29% of lignin removal was achieved. Sorghum straw at optimal pretreatment condition was subjected to enzymatic hydrolysis and fermentation. The efficiency of hydrolysis was measured by analyzing reducing sugars by 3, 5 dinitrisylicylic acid method. Reducing sugars of about 619 mg/g of sorghum straw were obtained after enzymatic hydrolysis. This study showed a significant amount of lignin removal and cellulose release at optimal condition. This enhances the yield of reducing sugars as well as ethanol yield. The study demonstrates the potential of microwave pretreatments for enhancing bioethanol yield from sorghum straw.

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