Abstract

The unsustainable management of rice-straw waste through open air burning practices is leading to drastic environmental impacts. A promising disposal route can be attained by its bioconversion into energy-rich biogas. The current work is aimed at optimization of organosolv pretreatment process for enhanced delignification and subsequently improved production of biogas from rice-straw. Ten different kinds of non-toxic organic solvents i.e., Ethanol, 1-propanol, 1-Butanol, Glycerol, Ethyl acetate, Citric acid, Lactic acid, Gluconic acid, Oxalic acid, and Acetic acid, were initially screened for their pretreatment efficiency under fixed operating conditions. Following screening experiments, using a one-parameter at a time approach, the influence of seven different physicochemical parameters (solvent concentration, time, temperature, catalyst type, particle size, solid-to-liquid ratio, and catalyst loading) on ethanol-based organosolv fractionation of rice-straw was further evaluated. Rice-straw with particle size <0.420mm when pretreated with 65% (v/v) concentration of ethanol, supplemented with 1.25% of 1N H_2SO_4, at 120°C for 60 minutes yielded optimal results i.e., a solid pulp having a 47.69% reduction in lignin content, a 62.7% detachment in hemicellulose content, and a 78.75% increment in cellulose availability. Additionally, the organosolv filtrate at optimal conditions yielded a reducing sugar yield of (0.5%). The structural modifications induced by optimized pretreatment in native substrate were further confirmed by FTIR analysis. The solvent reutilization experiments demonstrated relatively well-maintained pretreatment efficiency of solvent for three consecutive cycles. The results of cumulative biogas production from pretreated rice straw indicated proposed pretreatment was effective in yielding a 118.65% improved biogas yield than from native straw. Likewise, the 60.55 mL accumulated biogas production from organosolv hydrolysate revealed that the pretreatment was effective in ensuring maximum energy recovery from rice straw biomass. These findings confirm that the mild organosolv pretreatment proposed in the study is substantial in improving the biodegradability of rice straw.