ABSTRACT

Deep eutectic solvents have improved the processes of transformation and valorization of lignocellulosic feedstock owing to the ability to reduce biomass recalcitrance via delignification. Here, the effect of several deep eutectic solvents (DESs) was assessed on the halophyte *Atriplex crassifolia* to elevate the biogas production yield. At first, the halophyte was pretreated with a series of deep eutectic solvents including; carboxylic acids, amine/amide, and polyols/glycols-based deep eutectic mixtures. Among all, choline chloride with lactic acid (ChCl: LA) proved highly effective. Further optimization studies were also carried out by evaluating the effect of five pretreatment parameters including; molar ratio of DES constituents (1:1-2:1), reaction time (2-10h) and temperature (100-180 °C) solid-to-liquid ratio (1:5-1:25), and water addition (5-25%). The maximum pretreatment efficiency of 89.5% was attained by optimizing the reaction conditions at 120 °C for 4h with 15% water addition in ChCl: LA (1:2) DES at a biomass loading of 1:10. Under these fully optimized conditions, 79.3% cellulose retention was achieved while, solubilization rate (SR%) of ChCl: LA on *Atriplex crassifolia* also elevated to 38%. FT-IR analysis further confirmed the considerable removal of lignin content from the pretreated biomass. ChCl: LA was also recovered via vacuum distillation in order to evaluate the recyclability potential and pretreatment efficiency of the recovered DES. About ≥ 80% of the ChCl: LA was recovered up to five times and ≥ 85% of delignification efficiency was achieved till three pretreatment cycles. The fresh DES-pretreated *Atriplex crassifolia* when subjected to anaerobic digestion, generated biomass production yield of 32.2mL/g, which was far higher than the raw biomass. These findings demonstrated that ChCl: LA is highly effective in removing the lignin barrier from lignocellulosic materials, making cellulosic sugars highly accessible and readily biodegradable by microorganisms.