Abstract

Cellulose fibre has gained great interest in various industrial applications due to its excellent properties, such as biodegradability, biocompatibility, and renewability. Lignocellulosic food industry wastes, such as Distiller's Spent Grains (DSG), represent significant environmental burdens worldwide. DSG is a rich source of cellulose and offers a cheap feedstock alternative for the extraction of cellulose, provides a value-added route for the utilisation of DSG, presents cost savings, reduces waste from distilleries, and promotes a circular economy.

Deep eutectic solvent (DES) has recently emerged as an excellent solvent for the isolation of cellulose from lignocellulose biomass due to its non-toxicity, low cost, and ease of preparation. The combination of ultrasound energy with a suitable solvent, reaction time, and temperature can enhance biomass fractionation and improve cellulose recovery. This study investigates the application of ultrasound-assisted DES (choline chloride and formic acid, choline chloride: oxalic acid, and choline chloride: acetic acid) as an effective and green extraction medium for the selective dissolution of lignin and hemicellulose, leaving behind cellulose. Parameters such as DES composition, ultrasound treatment time, and biomass-to-DES ratio were optimised to enhance cellulose extraction efficiency. The obtained cellulose fibre is characterised in terms of purity, yield, and structural properties. Advanced analytical techniques such as scanning electron microscopy (SEM), X-ray diffraction (XRD), and Fourier transform infrared spectroscopy (FTIR) were used to evaluate the quality and morphology of the extracted cellulose.

The synergetic effect of ultrasound-assisted DES treatment demonstrates a high degree of lignin and hemicellulose solubilisation, whereas a significant improvement in cellulose yield and purity was observed in the sample treated with DES when compared with the untreated sample. DSG showed promising potential as an efficient, green, and environmentally friendly cellulose extraction method, opening new opportunities for the development of bio-based materials, reinforcing the importance of circular economy principles, and reducing the environmental footprint of the distillery industry.