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Research Article

# Green Degumming of Hemp Fibers Using Ternary Deep Eutectic Solvents

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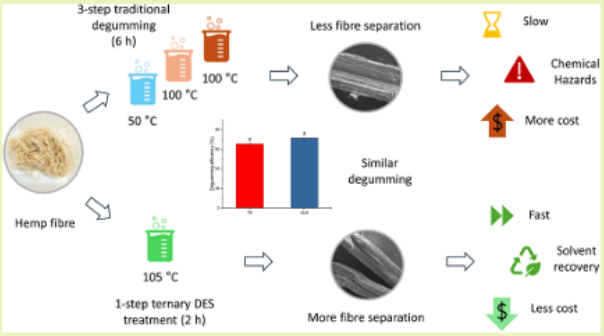
**ABSTRACT:** As the demand for natural fibers grows to replace fossil-based alternatives, bast fibers including hemp, jute, and flax are considered the most viable complement to cotton; however, they require degumming, a process that removes gummy substances such as pectin, lignin, and hemicellulose to make them suitable for further use. Eco-friendly degumming is essential to minimize the use of harsh chemicals and water, reducing environmental impact while preserving the natural qualities of the fibers. This study explores the potential of two ternary deep eutectic solvents (DESs): choline chloride/lactic acid/glycerol and choline chloride/lactic acid/urea while comparing them against a binary DES (choline chloride/lactic acid) and traditional degumming, as a green alternative for degumming hemp fibers. Among the tested conditions, the choline chloride/lactic acid/glycerol (1:5:2) and choline chloride/lactic acid/urea (1:5:2) DES formulations, applied at 105 °C for 2 h with a 1:20 bath ratio, showed the most efficient degumming performance and preserved fiber quality. By optimizing treatment conditions, ternary DES systems demonstrated effective removal of noncellulosic components, leading to enhanced fiber separation, improved crystallinity, and superior tenacity compared to the traditional method within a quicker time. Structural and thermal analyses confirmed the preservation of cellulose integrity, while solvent recovery and reuse at least for 4 cycles further underscored the feasibility of this approach for scalable industrial applications. The calculation of cost for chemicals, energy, and water for 4 degumming cycles demonstrated that the DES process was more economical compared to traditional degumming. The findings highlight ternary DES as a promising solution for sustainable fiber processing, paving the way for future research on its application across diverse bast fibers and lignocellulosic resources.




**KEYWORDS:** *ternary deep eutectic solvents, bast fiber, sustainable fiber processing, eco-friendly degumming, green chemistry*

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