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# EVALUATION OF KRAFT LIGNIN SOLUBILITY IN AQUEOUS SOLUTIONS OF DICARBOXYLIC- AND ALCOHOL-BASED DEEP EUTECTIC SOLVENTS


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## PURPOSE OF THE ABSTRACT

Lignocellulosic biomass is an abundant and renewable feedstock that presents the enormous potential of valorization in the context of bioeconomy [1]. The fractionation and conversion of main biomass components, including cellulose, hemicellulose, and lignin, are requirements to achieve sustainable exploitation of this raw material. In particular, the aromatic character of lignin has raised high interest in its exploration to develop value-added products for a wide range of applications, such as fuel, concrete additive, dispersant resins, adhesives and new biobased materials [2]. However, a lack of cheap, efficient and environmentally safe solvents for lignin dissolution is preventing the successful development of most of these applications. A promising approach for the dissolution of this macromolecule is the use of deep eutectic solvents (DES). DESs are special mixtures of at least two components, namely a hydrogen-bonding donor (HBD) and a hydrogen-boning acceptor (HBA) and they possess several advantages, including easy preparation, low cost, low toxicity and high biodegradability [3].

In this study, the solubility of Kraft lignin (from eucalyptus wood) in different DESs and their aqueous solutions was screened. Eleven DESs based on choline chloride (HBA) combined with two classes of HBDs (dicarboxylic acids and aliphatic alcohols) were prepared using the mild heating methodology. All DESs tested in this work were able to dissolve Kraft lignin. The ability of the five examined dicarboxylic acid HBD's to dissolve lignin can be ordered as the following: maleic > malonic > malic> oxalic, while the performance of alcohol HBD's can be ordered as follows: 1,6-hexanediol > 1,5-pentanediol > 1,4-butanediol > 1,3-propanediol > 1,2-ethanediol > glycerol. Among examined DESs, choline chloride:1,6-hexanediol (1:2) and choline chloride: maleic acid (1:1) presented the best performances achieving lignin solubility values of 34.5 wt% and 35.0 wt%, respectively. The influence of water, HBD carbon chain length, the number of hydroxyl groups in HBDs and temperature on the capacity of DES to dissolve lignin were evaluated. The addition of water reduced the solubility of lignin in all cases and a sharp decrease in the solubility was observed between 15-75 wt% water content. When water content becomes higher than 75 wt%, lignin solubility was < 5.0 wt%. Meanwhile, the increase in carbon chain length of HBDs, as well as the increase of temperature, implied in higher lignin solubility. On the other hand, the presence of an extra hydroxyl group in malic acid and glycerol structure resulted in lower solubility of this macromolecule. The examined DES demonstrated high ability to dissolve lignin and obtained data allowed to understand some fundamental aspects regarding the lignin solubility in these solvents. Moreover, this work discloses a high potential of DES as alternative solvents to be successfully employed in biomass delignification processes and/or lignin conversion technologies.

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## FIGURES

### FIGURE 1

### FIGURE 2

### KEYWORDS
Deep eutectic solvents | Lignin | Solubility | Sustainability

## BIBLIOGRAPHY