ISGC 2019
May 13rd - 17th

N°176 / OC
TOPIC(s) : Biomass conversion / Alternative solvents

Extraction and in situ saccharification and fermentation of xylans for the production of xylitol in deep eutectic solvents

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PURPOSE OF THE ABSTRACT

Deep eutectic solvents (DES) have emerged as greener alternative solvents due to their simple preparation and unique physicochemical properties. Moreover, they are often of natural origin, biodegradable and recyclable [1]. Due to these properties, they are good candidates to be used in biotechnological processes, as well as one of the most promising solutions for biomass fractionation [2]. Thus, both approaches could be combined to develop integrated processes for biomass valorization. Nevertheless, for a complete understanding of their applicability, it is necessary to evaluate the biocompatibility of these solvents with both biomass fractionation and biotechnological processes required in the subsequent stages of biomass bioconversion.

We have demonstrated that aqueous solutions of Cholinium Chloride:Urea ([Ch]Cl:U) dissolve xylan up to 328 ± 29 mg/mL [3]. This value is significantly higher than those achieved in alkaline solutions. Due to these good results, extraction of xylans from Eucalyptus globulus wood was attempted under optimized conditions. A yield close to 15 wt.% was obtained using [Ch]Cl:U aqueous solutions, performing better than aqueous NaOH and water. These promising extraction results and the DES mild pH conditions suggested that in situ xylan conversion could be attempted to further valorize the process. Therefore, the main aim of this work is to develop an integrated approach for xylans extraction from woods with [Ch]Cl:U, with a subsequent simultaneous saccharification and fermentation (SSF) into xylitol. Assays were carried out using a recombinant Saccharomyces cerevisiae strain previously engineered to over produce xylitol [4]. The effect of DES molar ratio on enzymatic saccharification of xylan was evaluated. Moreover, DES/xylan concentrations, enzyme loading and glucose concentration were varied and the SSF process optimized through Box-Behnken Experimental Design.

Overall, the results obtained show that xylitol can be produced using aqueous DES-xylan extracts. Furthermore, the DES molar ratio of 1:1 has the smaller negative effect in enzymatic saccharification, resulting in the highest xylitol production. This molar ratio was further used to carry out the process optimization. This work highlights the possibility of using directly aqueous DES solutions for an integrated extraction of xylans from wood and their

conversion into added value products, thus contributing to the development of sustainable processes.

Acknowledgments

This work was developed in the scope of the project CICECO, POCI-01-0145-FEDER-007679 (Ref. FCT UID/CTM/50011/2013) and strategic funding of UID/BIO/04469/2013 unit, financed by national funds through the FCT/MEC and co-financed by FEDER under the PT2020 Partnership Agreement. The research leading to reported results has received funding from FCT through the projects DeepBiorefinery (PTDC/AGR-TEC/1191/2014), MultiBiorefinery (POCI-01-0145-FEDER-016403) and through C. Freire Researcher contract (IF/01407/2012), and from the European Research Council under the European Union's Seventh Framework Programme (FP7/2007-2013)/ERC grant agreement no. 337753. The authors would also like to thank BioTecNorte operation (NORTE-01-0145-FEDER-000004) funded by ERDF under the scope of Norte2020, the Biomass and Bioenergy Research Infrastructure (PINFRA/22059/2016) and the EcoTech project (POCI-01-0145-FEDER-032206). E. S. Morais is thankful to FCT for the financial support from the doctoral grant (SFRH/BD/129341/2017).

FIGURES

FIGURE 1

FIGURE 2

KEYWORDS

Deep eutectic solvents | integrated biomass conversion | xylans | xylitol

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