Recovery of carbohydrates from crop residues with ionic liquids

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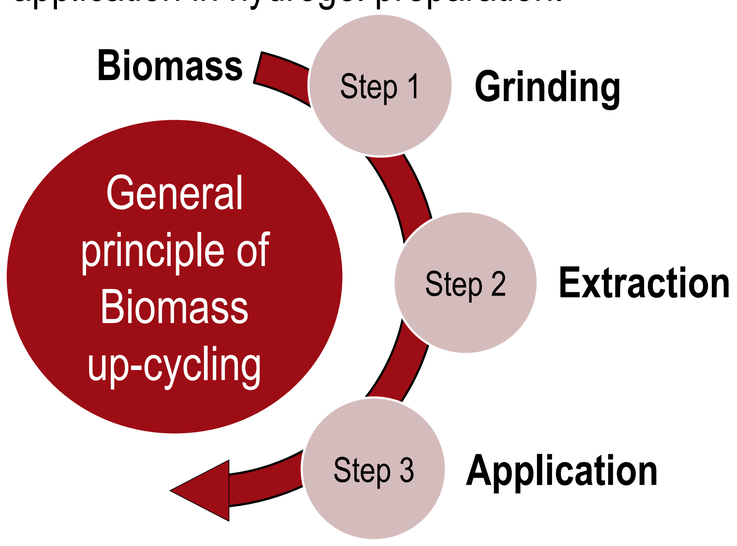
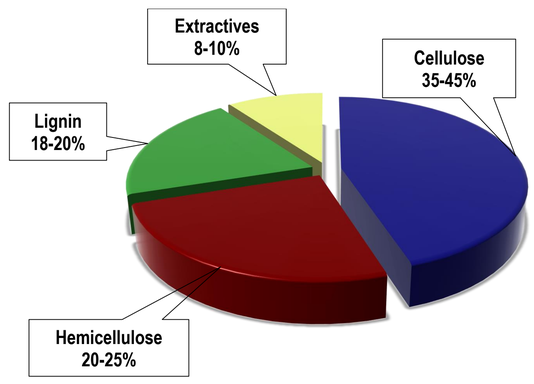
Introduction

Nowadays, agriculture is the main priority to reach the Sustainable Development Goals. Its development is accompanied by increasing of crop residues (e.g. cereals hull, straw, corn stover). The standard treatment comprises mainly the direct burning of rice straw on the land resulting in an increase of CO_2 emission, degrading land, air pollutant and global warming. However, to overcome these negative impacts we should utilize this biomass effectively. The aim of this study involves the process of innovative cellulose dissolution with ionic liquids as well as further application in hydrogel preparation.

Burning of rice straw and other biomass is practiced in most Asia countries





Chemical compostion of rice straw [1]

Results and Discussion

Step 1: Grinding rice straw by planetary ball mill

Advantages:

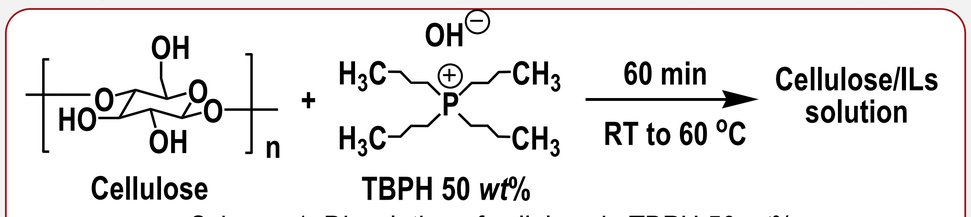
- Easy approach and environmentally friendly
- Increasing the accessible surface area
- Decreasing the crystallinity of cellulose
- Decreasing the polymerization degree
- Accelerating dissolution in Ionic liquids [2]

Optimization of the grinding conditions

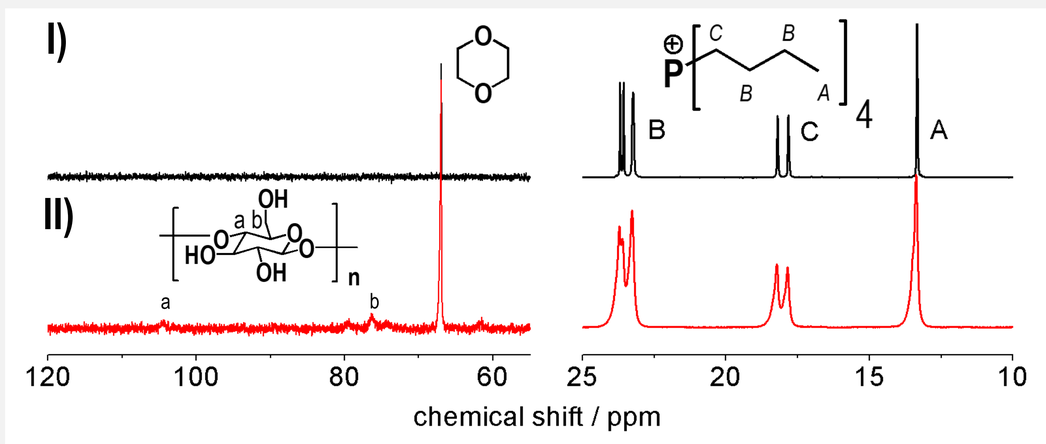
- Time: 90 min
- Speed: 400 rpm
- Material: Stainless steel
- Number of balls: 15 balls

Step 2: Extraction cellulose with Ionic liquids

Ionic liquids (ILs) e.g. Tetrabutylphosphonium hydroxide 60 *wt*% have been found to be able to efficiently dissolve cellulose due to the numerous inter- and intra-molecular hydrogen bonds between polymeric chains (Scheme 1) [3].



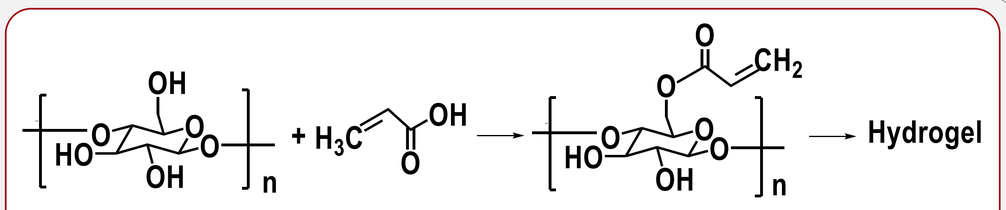
Scheme 1: Dissolution of cellulose in TBPH 50 *wt*%



^{13}C NMR spectra of TBPH 50% I) with internal standard and II) additional cellulose

Step 3: Application

For further studies, we would like to apply this extracted cellulose for esterification introducing a double bond for polymerization. E.g. acrylic acid will be used as esterifying agents (Scheme 2).



Scheme 2: Esterification of cellulose and acrylic acid

Summary and Outlook

- Efficient grinding of rice straw by planetary ball mill resulting in powder with high surface area.
- Dissolution of cellulose with Tetrabutylphosphonium hydroxide (TBPH) and detection cellulose with ^{13}C NMR.
- Possible modification by esterification of cellulose and acrylic acid.

References

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[3] M. Abe *et al.*, "Fast and facile dissolution of cellulose with tetrabutylphosphonium hydroxide containing 40 wt% water," *Chem. Commun.*, vol. 48, no. 12, p. 1808, 2012.

Acknowledgements

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