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Next-Generation Lignocellulosic Materials

Background

SDG implementation dictates the utilization of renewable natural resources. Woody biomass is a useful renewable organic resource. Plant cell wall is mostly made of polysaccarides, cellulose and hemicellulose, and lignin, which are linked together in a highly complex structure and comprise the bulk of trees' biomass. Despite high potential of lignin, it is mostly discarded or burnt as a byproduct in the pulp and paper industry. Therefore, among the structural biomass compounds only the polysaccharides are used for various applications. The present invention is a novel method of biopolymer isolation including high quality lignin.

Technical Summary

The inventors developed a sequential separation method to extract undamaged lignin, cellulose, and hemicellulose from plant biomass. By exposing plant biomass to sequential hydrothermal and glycerol-based organosolv processes, followed by a mild organic acid-based extraction step, not only cellulose and hemicellulose are recovered, but high purity lignin with a preserved aromatic structure is obtained (Fig.1, Chotirotsukon et al. 2021)

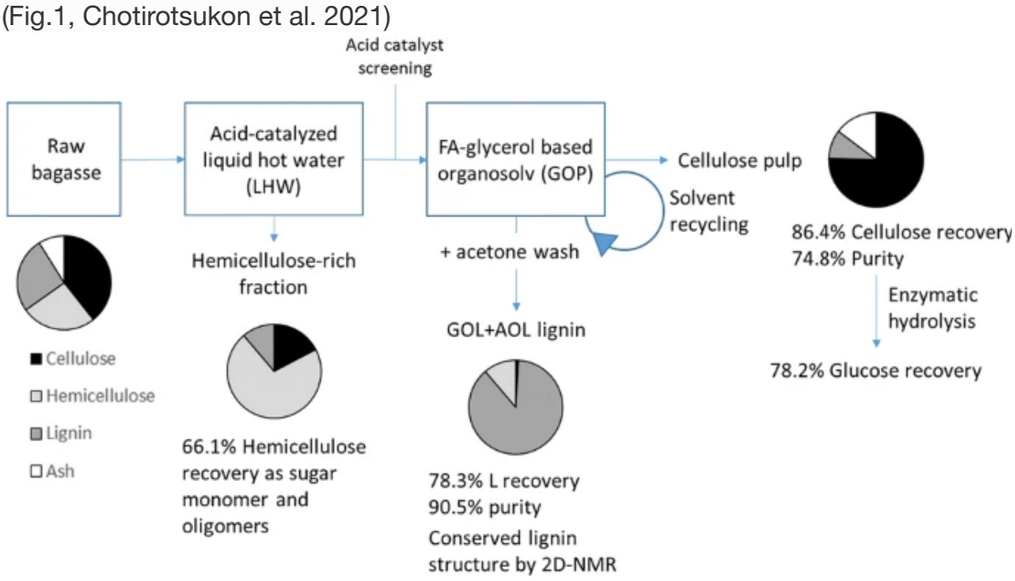

Figure 1. Workflow of biopolymers extraction from sugarcane bagasse.

The lignin extraction process requires low energy input, no use of strong acid/base and metal catalyst. The organic solvent can be recycled and reused. The extraction process does not lead to water pollution and provides high purity soluble colorless lignin. The majority of original biomass cellulose and hemicellulose are also recovered and can be used for various applications.
The researchers are working on multiple applications for the extracted lignin as a next-generation material. These include using self-assembling lignin capsules for drug delivery, UV-A and UV-B absorbing lignin-derived compounds for sunscreens (Fig.2, Mikame et al. 2021), and lignin–carbohydrate complexes as antiviral agents (Li et al. 2021).

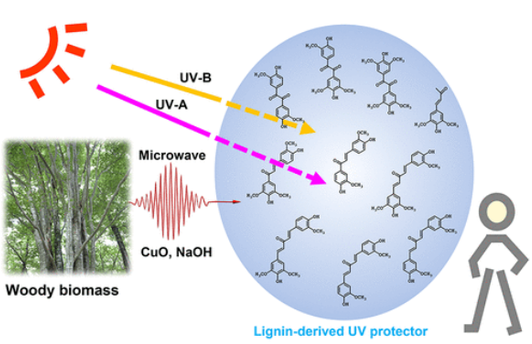

Figure 2. Microwave-assisted alkaline cupric oxide oxidation of lignin produces compounds that absorb UV-A and UV-B radiation.

Technology Readiness Level

- 3

Potential Applications

- Sunscreens
- Drug delivery
- Antivirals

Possible Collaboration Mode(s)

- R&D collaboration
- Licensing
- IP Acquisition
- Other

Patent No

WO/2022/118583

Publication(s)

Choti Rotsukon C, Raita M, Yamada M, Nishimura H, Watanabe T, Laosiripojana N *et al.* Sequential fractionation of sugarcane bagasse using liquid hot water and formic acid-catalyzed glycerol-based organosolv with solvent recycling. *Bioenergy Res* 2021; **14**: 135–152.

Mikame K, Ohashi Y, Naito Y, Nishimura H, Katahira M, Sugawara S *et al.* Natural Organic Ultraviolet Absorbers from Lignin. *ACS Sustainable Chem Eng* 2021; **9**: 16651–16658.

Li R, Ouda R, Kimura C, Narita R, Nishimura H, Fujita T *et al.* Conversion of Beech Wood into Antiviral Lignin–Carbohydrate Complexes by Microwave Acidolysis. *ACS Sustainable Chem Eng* 2021; **9**: 9248–9256.

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