ISGC 2022

N°585 / OC
TOPIC(s) : Biomass conversion

Integrated biorefinery approach towards (nano)cellulose, furanics and phenolic value-added chemicals

AUTHORS

ANTIGONI MARGELLOU / ARISTOTLE UNIVERSITY OF THESSALONIKI, UNIVERSITY CAMPUS, THESSALONIKI
ELENI PSOCHIA / ARISTOTLE UNIVERSITY OF THESSALONIKI, UNIVERSITY CAMPUS, THESSALONIKI
Corresponding author : KONSTANTINOS TRIANTAFYLLIDIS / ktrianta@chem.auth.gr

PURPOSE OF THE ABSTRACT

Lignocellulosic biomass derived from agricultural and forestry residues as well as food industry wastes could be a promising and renewable source of value-added chemicals, substituting petroleum-based chemicals. Lignocellulosic biomass, composed of cellulose, hemicellulose and lignin can be converted not only to fuels but also to a wide variety of platform chemicals which can be further utilized in polymers, pharmaceuticals and other industries. Within the "biorefinery" context, the aim of this work is the valorization of "whole biomass" towards the production of (nano)cellulose, platform chemicals and fuel additives from hemicellulose (furanics) and lignin streams (phenolics/aromatics) via cascade thermochemical and (bio)catalytic processes.

The first and the most important step in the efficient valorization of lignocellulosic biomass is the pretreatment, aiming to the fractionation into its main structural components. One of the most efficient fractionation methods is the hydrothermal treatment in pure water, under autogenous pressure, a "green" process which can be applied to a wide variety of feedstocks (prunings, straws, kernels, etc.). During this process, hemicellulose is removed to the liquid fraction while cellulose and lignin are remained in the solid fraction [1-3]. The composition of the recovered fractions was controlled by the severity of the process (time, temperature and catalyst). Moderate treatment severities resulted in xylan/xylose monomers and oligomers, while under higher severities xylose was converted into furfural and organic acids. The addition of dilute acid as catalyst, allowed milder conditions leading to increased hemicellulose removal mainly towards xylose monomers. Furfural, produced by in situ or down-stream dehydration of xylose, can be utilized as monomer for the production of resins or can be converted via catalytic hydrogenation into other value added furanics (furfuryl alcohol, methylfuran, etc.) which can serve as fuel additives, solvents and monomers for polymers synthesis [4-5].

Subsequently, surface lignin formed during the hydrothermal pretreatment was extracted from the pretreated solids under mild conditions with "green" and easily recoverable solids (acetone, ethanol) leaving a cellulose rich solid biomass [3]. The isolated lignins can be directly utilized as additive in resins or can be converted via (catalytic) fast pyrolysis or hydrogenolysis into phenolic and/or aromatic monomers which can be used in resins and polymers synthesis, as well as in fuel production [6].

The cellulose-rich solid biomass obtained after lignin removal can be utilized as feedstock to produce a wide variety of value-added chemicals. Glucose can be obtained via enzymatic hydrolysis using commercially available enzymes which can be further converted to bio-ethanol or bio-succinic acid via fermentation. Furthermore, glucose can be converted via catalytic (hydrolytic) hydrogenation into sugar alcohols/polyols and glycols [3, 7]. Alternatively, in the present work, the residual lignin was removed from the pretreated solids via bleaching providing a highly crystalline clean white cellulose powder which was then transformed to micro/nanocellulose via either mechanical processes (ultrasonication, high shear blending, and milling) or chemical (acid hydrolysis) treatment. The obtained nanocellulose can serve as additive in polymers synthesis (i.e. urea formaldehyde (UF) and epoxy resins). The combined biomass pretreatment-lignin extraction approach described in this work could lead to enhanced recovery of the three main components of lignocellulosic biomass, facilitating their down-stream

valorization to produce value-added chemicals, monomers and (nano)materials.

This research has been co-financed by EU-European Regional Development Fund and Greek funds via EPAnEK 2014-2020, under "Special Actions "Aquaculture"-"Industrial Materials"-"Open Innovation In Culture"(project code: T6YBP-00341).

FIGURES

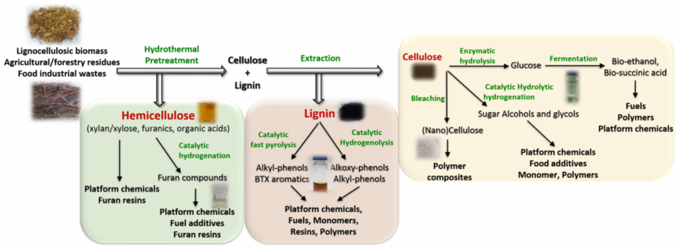

FIGURE 1

Figure 1.

Integrated lignocellulosic biomass valorization scheme towards the production of value-added chemicals.

FIGURE 2

KEYWORDS

Biorefinery | Hydrothermal pretreatment | Nano-cellulose | Lignin bio-oils

BIBLIOGRAPHY

[1] C.K. Nitsos et al., ChemSusChem 2013, 6(1) 110.

[2] C. K. Nitsos et al., ACS Sustainable Chemistry & Engineering 2016, 4(9) 4529

[3] C. Nitsos et al., ChemSusChem 2019, 12 179.

[4] Y. Wang et al., ACS Sustainable Chemistry & Engineering 2018, 6(8) 9831.

[5] Y. Wang et al., ChemCatChem 2018, 10(16) 3459.

[6] A.G. Margellou et al., Applied Catalysis A: General 2021, 623 118298.

[7] P. A. Lazaridis et al., Applied Catalysis B: Environmental 2017, 214, 1.