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TOPIC(s) : Biomass conversion

Reductive catalytic fractionation of tree bark: a source of phenolics and alfa,omega-bifunctional, long-chain alkanes

AUTHORS

Thijs VANGEEL / KULEUVEN, CELESTIJNENLAAN 200F - BUS 2461, LEUVEN

Tom RENDERS / KULEUVEN, CELESTIJNENLAAN 200F - BUS 2461, LEUVEN

Sander VAN DEN BOSCH / KULEUVEN, CELESTIJNENLAAN 200F - BUS 2461, LEUVEN

Gil VAN DEN BOSSCHE / KULEUVEN, CELESTIJNENLAAN 200F - BUS 2461, LEUVEN

Korneel VAN AELST / KULEUVEN, CELESTIJNENLAAN 200F - BUS 2461, LEUVEN

Corresponding author : Bert SELS / bert.sels@kuleuven.be

PURPOSE OF THE ABSTRACT

Tree bark is a major side stream from wood processing industries (e.g. pulp and paper industry, timber production). Currently, its uses are limited to low-value applications, such as burning for energy recuperation and soil coverage in horticulture. This makes bark a cheap and readily available feedstock for future biorefineries.

Chemically, bark consists of carbohydrate polymers (cellulose, hemicellulose and pectins), phenolic polymers (lignin and condensed tannins), aliphatic polymers (suberin), extractives and inorganics. Compared to wood, bark has a higher lignin content, a higher amount of extractives and contains suberin and tannins, which are not present in wood.

Recently, a novel biorefinery scheme, termed reductive catalytic fractionation (RCF), was developed for lignocellulosic biomass (e.g. wood) in order to create added value from lignin.¹ During this process lignocellulosic biomass is processed in an organic solvent (e.g. methanol)²⁻³ at elevated temperatures (473-523 K) in presence of a redox catalyst under hydrogen atmosphere. Lignin is solvolytically extracted from the lignocellulosic matrix and the reactive intermediates are reductively stabilized through the action of the redox catalyst (e.g. Pd/C, Ru/C),⁴ resulting in a highly depolymerized lignin oil (near theoretical monomer yield) and a solid carbohydrate fraction.

This contribution aims to evaluate the use of tree bark with a high suberin content as feedstock for the RCF process. During this process, lignin and suberin are effectively depolymerized into (A) phenolic monomers and oligomers, and (B) (mainly) alfa,omega-bifunctional alkanes, respectively. These long-chain aliphatics (C16-C26) are derived from the suberin polyester structure and comprise (i) alfa-OH methyl esters and (ii) dimethyl esters, with smaller amounts of (iii) methyl esters and (iv) alkanols. Especially these alfa,omega-bifunctional, long-chain alkanes can interesting building blocks for specialty polymers or cosmetics applications. A subsequent separation of the resulting phenolics and aliphatics after RCF is demonstrated. Furthermore, the overall mass balances of the carbohydrate, lignin and suberin fraction in bark will be critically evaluated.

FIGURES

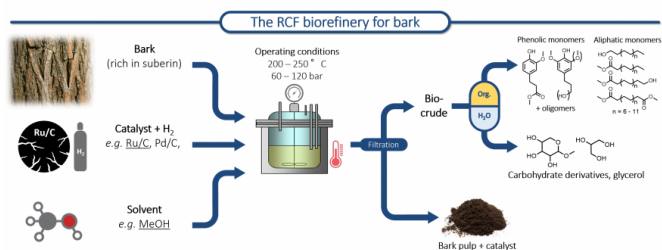


FIGURE 1

RCF process scheme for tree bark with downstream separation

Upon filtration, a solid 'bark pulp' is obtained. Liquid/liquid extraction (CHCl₃/water) of the soluble products results in a 'bark oil', containing mainly lignin- and suberin-derived products.

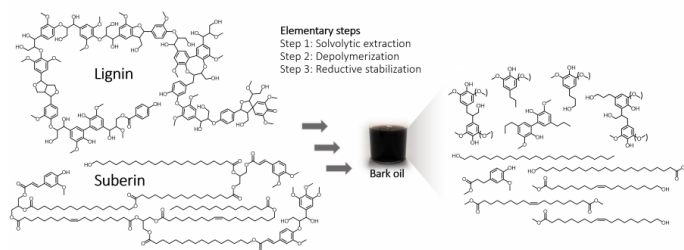


FIGURE 2

Disassembly of lignin and suberin during RCF

Lignin and suberin are extracted from the biomass matrix and solvolytically depolymerized. Lignin fragments are reductively stabilized to enable a low MW lignin fraction rich in monomers.

KEYWORDS

Bark | Lignin | Depolymerization | Reductive catalytic fractionation

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