Abstract

**Combination of chemo-mechanical pretreatments of rice straw in semi-humid pathway: effect on physicochemical, rheological properties and reactivity.**

Lignocellulosic biomass (LC) is considered as a promising alternative in order to produce not only biofuels, but also green chemicals and materials and bio-based molecules for the synthesis of polymers, which could substitute those from petrochemicals. The LC biomass mainly consists of cellulose, hemicelluloses and lignin. Its composite nature and its heterogeneous matrix microstructure make difficult its enzymatic degradation and its bioconversion. The pretreatment of LC biomass is a required step that allows deconstructing the LC matrix and improving the accessibility to the parietal polymers, in particular for the production of bio-based molecules.

Dry fractionation of LC biomass can take place in biorefinery with favorable arguments with regards to the durability (no water consummation, no drying, and no effluent generation). The improvements of resolution in LC fractionation, the reduction of energy consumption as well as the enhancement of reactivity/features of products constitute three priority objectives of research in the dry fractionation field. One inconvenience of grinding operation is high-energy consumption. So, the development of mild pretreatments, which can facilitate the grinding process of the LC matrix and the accessibility to substrates, might contribute (i) to improve the resolution of dry fractionation, (ii) to reduce significantly the energy consumption by grinding and (iii) to improve the product reactivity.

The objective of the thesis concerns the characterization of the combination of chemical and mechanical pretreatments of rice straw. This study focuses in particular on an innovative process of chemical pretreatment by semi-humid pathway, which allows weakening the LC matrix in order to facilitate its mechanical deconstruction. The semi-humid chemo-mechanical coupled processes allowed at the same time increasing the product reactivity, decreasing the energy consumption as well as eliminating some steps, while generating no effluents. The results of dry fractionation showed that the combination of an ultrafine grinding and separation steps is a useful alternative technique in biorefinery to obtain interesting fractions with contrasted properties. These results permit to propose a pretreatment technique that can be adapted to many kind of biomass.

A hydro-textural approach at the particle size scale is then proposed in order to better understand the mechanisms of fractionation and evaluate the effects of chemical pretreatments. The role of microstructure in response to the chemo-mechanical pretreatments is analyzed, in particular by studying the mass transfers (water) in powders (imbibition and drying). A physical characterization of powders completes the description of the properties conferred to the ground rice straws. Beyond the obtained results, this study allowed to propose an original way to describe and understand the effects of fractionation tools that can be applied further to other kind of biomasses and other processes.

**Keywords:** biorefinery, rice straw, pretreatment, grinding, hydro-textural approach, rheological properties, energy consumption, bioconversion