ISGC 2022

N°1221 / PC
TOPIC(s) : Waste and side streams valorization / Alternative technologies

Mechanocatalytic depolymerization of hemicellulose side streams for xylo-oligosaccharides obtaining

AUTHORS

Jonathan Fabian SIERRA CANTOR / IC2MP, 4 RUE MICHEL BRUNET, POITIERS
François JÉRÔME / IC2MP, 4 RUE MICHEL BRUNET, POITIERS
Gilles LABAT / FCBA, ALLÉE DE BOUTAUT ? BP 227, BORDEAUX
Denilson DA SILVA PEREZ / FCBA, DOMAINE UNIVERSITAIRE ? CS 90251, GRENOBLE
Karine DE OLIVEIRA VIGIER / IC2MP, 4 RUE MICHEL BRUNET, POITIERS

PURPOSE OF THE ABSTRACT

Oligosaccharides market has been increasing in the recent years owing to their use as healthy bio-based component in food and beverages as well as building blocks for the synthesis of specialty chemicals [1]. This growing demand for probiotic molecules, forces the chemical industry to diversify their sources. Among them, the use of lignocellulosic biomass represents a local, abundant and cheap renewable feedstock. Although cellulose has important industrial uses, side-streams of hemicellulose represents an underutilized source of sugars [2]. Moreover, the heterogeneity of hemicelluloses, as compared to that of cellulose, could lead to oligosaccharides with different properties, and thus, different performances/applications. Considering it, in this work, we synthesized xylo-oligosaccharides (XOS) starting from hemicellulose from blanched pulp wastes (Pulp-HEM), through a mechanocatalytic depolymerization [3]. It was carried out by the milling of the isolated hemicellulose in a planetary ball mill along with a perfluorosulfonic acid polymer (Aquivion®) as heterogeneous catalyst [4].

In the one hand, parameters such as hemicellulose wetness, catalyst loading, and time of ball milling were evaluated to maximize the depolymerization performance. It was found that the mechanocatalytic depolymerization efficiency increased with the decrease of the Pulp-HEM wetness. A total conversion of Pulp-HEM, with a wetness of 3.0 wt. %, to water soluble oligosaccharides was reached (200 wt. % of catalyst loading, 12 h of ball milling). Evaluating the effect of the different studied parameters, it was possible to conclude that the wetness in the sample had the most significant effect on the depolymerization performance. It is due to buffer effect of water on the mechanical force applied to depolymerize the oligosaccharides. As expected, it was found that the yield in xylo-oligosaccharides increased with the catalyst loading (Figure 1). Based on these results, the catalyst loading chosen for the recycling tests was 100 wt. %. Under these conditions (100 wt. % of catalyst loading, 12 h of ball milling), the Aquivion® was recycled up to three cycles.

On the other hand, the obtained XOS were characterized by NMR and MS technics. These analyses showed that the water soluble XOS have a degree of polymerization lower than 10. They are mainly composed by xylose, rarely attached with hexose monosaccharides. The presence of side group as carboxyl groups was not observed.

As conclusion, it was possible to obtain industrially relevant low molecular weight xylo-oligosaccharides from the hemicellulose obtained from the side streams from blanched pulp wastes.

FIGURES

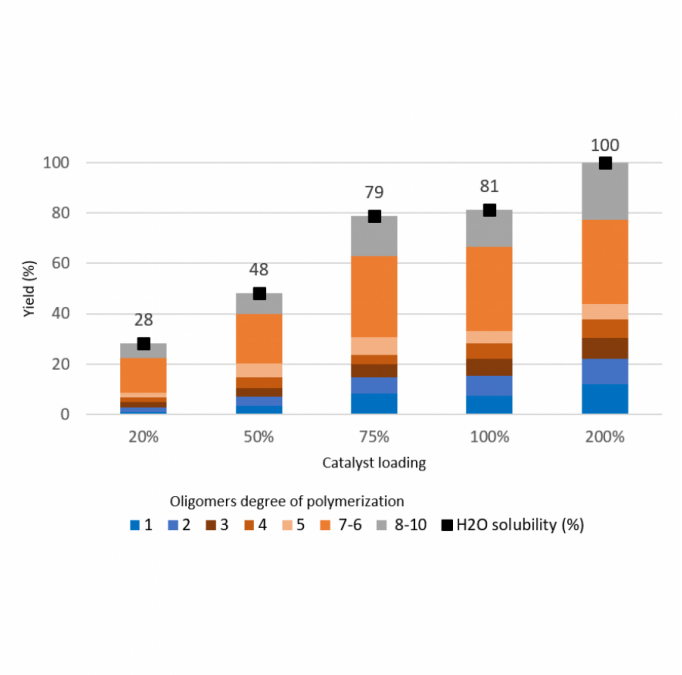

FIGURE 1

Effect of the catalyst loading on the mechanocatalytic depolymerization of Pulp-HEM
(wetness 3 %, 12 h of ball milling).

FIGURE 2

KEYWORDS

Hemicellulose side streams | Xylo-oligosaccharides | Mechanocatalytic depolymerization | Blanched pulp wastes

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