Influence of catalyst type and temperature on the enzymatic hydrolysis of extrusion pretreated barley straw

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In the context of second generation bioethanol production from lignocellulosic biomass, extrusion has been tested as a pretreatment method in various configurations and has proved to achieve a good destructuration of the lignocellulosic matrix that results in enhanced susceptibility of the biomass to the enzymatic attack [1]. Particularly, alkaline extrusion at low temperature has been reported to produce a high deacetylation of the hemicellulose and no or small amounts of sugar degradation compounds, resulting in a substrate with reasonable good enzymatic hydrolysis yields and ethanol production [2].

The aim of this study was to compare the performance of two alkaline reagents and process temperatures in extrusion of barley straw for sugar production by enzymatic hydrolysis. The raw material used for the extrusion experiments was barley straw milled to 2 mm. A sequence of operations is carried out inside the extruder: alkaline pretreatment, neutralization and filtration [2]. For the experiments presented in this work, the alkaline and basic solutions used were either NaOH (8.5% w/v) and H_3PO_4 (0.5M), or KOH (8.5% w/v) and H_2SO_4 (0.5M). Three temperatures: 70, 90 and 110ºC were tested. After the pretreatment, enzymatic hydrolysis was carried out with 15 FPU/g dry matter of a commercial enzymatic cocktail kindly provided by Novozymes A/S (Denmark).

Results show a significant increase of the glucan and xylan hydrolysis yields as the temperature increases, for both alkali reagents, reaching glucan and xylan conversions around 80%. However, at 110ºC some xylan losses are measured. The positive effect of the temperature on the enzymatic hydrolysis is more progressive when NaOH is used, having a significant improvement already at 90ºC, whereas it is necessary to reach 110ºC to see similar yields with KOH. The difference between both alkaline catalysts can also be observed in terms of removal of acetyl groups, which is twice as efficient with NaOH as with KOH.

Briefly, results of this work show the high potential of alkaline extrusion as pretreatment for barley straw as a fractionation method that enhances the conversion yields of this feedstock into sugars and in a further step, fuel ethanol.

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References

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