**A Combination of Bio- and Chemo-Conversion**

**of the Hemicellulose Xylan to Xylitol**

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**Highlights**

* Enzymatic hydrolytic hydrogenation of xylan to xylitol is possibel
* A hybrid one pot process achieved over 70% xylitol yield

**1. Introduction**

Lignocellulosic biomass consisting of the fractions cellulose, hemicellulose and lignin is a promising sustainable basis for a future biorefinery. They are many applications for cellulose for example in the pulp and paper industry. For an efficient operating of a future lignocellulosic biorefinery it’s essential to include the fractions lignin and hemicellulose. Hydrolysis is a key step in this process. The focus of this work is the simultaneous use of chemical and biological catalysts and the combination of their advantages in one reactor for the conversion of xylan (beechwood) to xylitol. This involves the discussion of a classical one-pot and a new two-step process.

**2. Methods**

The experiments were carried out in a stainless steel batch reactor (Parr Inst.) with an inner volume of 300–600 ml. The analysis was performed by an HPLC (Smartline®, Knauer GmbH) unit. Hydrolysis was done by using commercially available enzymes. The subsequent refinement of the hydrolysis products was realized with the aid of a Ru/C catalyst.

**3. Results and discussion**

The classical one-pot process was carried out at a temperature of 60 °C, 20 bar hydrogen pressure and a stirring speed of 1000 rpm. The process realized under the before mentioned conditions achieved a xylitol yield below 20% after 8 hours. This is very low compared to the existing industrial process using Raney-Nickel.

The two-step process is composed of the following steps: 1. step hydrolysis followed by the 2. Step hydrogenation. The hydrolysis (1) is carried out at 250 rpm (low shear-stress), 50 °C and atmospheric pressure for 24 hours reaction time. After the hydrolysis phase the subsequent hydrogenation (2) was carried out at process conditions of 10 bar hydrogen pressure, 140 °C, stirring of 750 rpm under use of gas-entrainment and a reaction time of 4 hours. Comparably mild reaction parameters were chosen to maintain the enzyme activity for as long as possible under hydrogenation conditions. During the hydrolysis, with different enzyme loadings, a xylan conversion of around 70% was achieved. In the subsequent hydrogenation, the xylan conversion increases by approximately 10%. Control experiments show that under these conditions no xylan hydrolysis without enzymes takes place. After the second process stage, a xylitol yield of over 70% is achieved.



**Figure 1.** Fig. 1 xylan (1 wt%) conversion via two-step process with different enzyme loadings (250 rpm, 50 °C, atmospheric) during the 1st step 24 h and hydrogenation at 140 °C during 2nd step 4 h at 10 bar H2 in the presence of 3 g/kg Ru catalyst (5 wt% Ru on act. C) [1]

**4. Conclusions**

The experiments show that enzymatic hydrolytic hydrogenation of xylan to xylitol is possible at low (60 °C) temperatures. The xylitol yield can be considerably increased by the application of a suitable reactor operating mode as a two-step process.

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**References**

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