ABSTRACT

IMPROVEMENT OF THE EFFICIENCY OF THE LIGNOCELLULOSIC FEEDSTOCK BIOCONVERSION TO ETHANOL THROUGH DETOXIFICATION OF HYDROLYSATES FROM THE WOOD OF WILLOW (*SALIX* L.) AND POPLAR (*POPULUS* L.)

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Conversion of lignocellulosic biomass to bioethanol, due to the specific chemical structure of biopolymers of cellulose, hemicelluloses and lignin, is based on four major processes: physicochemical pre-treatment, enzymatic hydrolysis, alcohol fermentation and distillation. However, depending on specific conditions in which the physicochemical processing stage is carried out, a certain pool of products is generated, which present inhibitory properties, thereby having an adverse influence of microorganisms that participate in ethanol fermentation, which leads to an inferior efficiency of the entire process. To improve the efficiency of the conversion of lignocellulosic biomass to ethanol, prior to alcohol fermentation, it is justifiable to conduct detoxification of the hydrolysate.

The purpose of this study has been to analyse the effectiveness of the detoxification of hydrolysates that involves two mineral adsorbents, zeolite and halloysite, in the process of bioethanol production.

The study material consisted of lignocellulosic biomass chips from two short rotation woody crops species: willow (*Salix viminalis*) and poplar (*Populus nigra x Populus maximowiczii*). Ground material was submitted to the processes of acid pre-treatment, using weak phosphate (V) acid (H_3PO_4), and subsequently enzymatic hydrolysis with cellulosic preparations. The hydrolysates obtained from these processes underwent detoxification using adsorption methods. Thus, the effectiveness of the selected adsorbents in the removal of inhibitory compounds was tested. With the aid of liquid chromatography methods, determinations were performed to identify the quantities of fermenting sugars that belong to hexoses (C6) and pentoses (C5) in the hydrolysates. Afterwards, changes in concentrations of selected compounds from the groups of furans and phenols, recognised as inhibitors of the fermentation process, were determined. Finally, the hydrolysates underwent fermentation and the process efficiency indicators were analysed.

The results of the study led to the determination of conditions in which detoxification of wood hydrolysates, obtained in acid pre-treatment (hydrolysate H1) and enzymatic hydrolysis (hydrolysate H2), with the use of an adsorbent. It was demonstrated that the inclusion of detoxification into the technological line of bioethanol production had a positive impact by improving the fermentation distinguishing indicators in each analysed variant. In comparison with the reference process without detoxification, the efficiency of fermentation after the detoxification of hydrolysates H1 with zeolite improved by an average of 17.4% and with halloysite – by 12.7%. In the variant with hydrolysate H2, the improvement in the process efficiency was 30.4% when zeolite was applied and 37.7% after using halloysite. In turn, the final concentration of ethanol in the digestate medium following the detoxification of hydrolysates H1 with zeolite increased by 40.0% and when halloysite was used, it rose by 37.5%. When hydrolysates H2 were detoxified with zeolite, this parameter improved by 43.8%, and when halloysite was applied as an adsorbent, the increase reached 50.0%.