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L-lactic acid production from cellulose and hemicellulose extract of walnut shell through microwave-assisted autohydrolysis followed by microbial fermentation

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Conversion of lignocellulosic biomass to renewable and valuable chemicals has attracted global attention because it is a better alternative pathway to reverse the negative environmental impact and ultimately build up a sustainable society. Lactic acid has become a valuable chemical due to its versatile application in the food, medical, and cosmetics industries and as raw material for the manufacture of biodegradable plastics. Lignocellulosic biomass is a promising feedstock for lactic acid production considering its abundance and low cost compared to refined sugars. In this study, autohydrolysis of the amorphous region of cellulose and hemicellulose in the walnut shell through microwave-assisted reaction at selected temperature ranges (150°c, 170°c, and 190°c) with the residence time (20 min, 40 min, 60 min) were investigated. The corresponding severity factor of the hydrolysis was calculated. At a reaction condition of 190°C, 20 min, a maximum theoretical yield of 98% of xylose and 21.6% of glucose was obtained. Subsequently, the obtained hydrolysate from the maximum yield was converted to optically pure L-lactic acid. This was achieved by using inhibitor resilient bacteria Bacillus coagulans DSM 2314. This bacterium converted the higher amount of xylose from the hemicellulose to an optically pure L-lactic acid with a considerable utilization of the glucose present in the hydrolysate into optically pure L-lactic acid.

Recent Publications

1. Güell E J, Maru B T, Chimentao R J, Gispert-Girado F, Constantí M and Medina F (2015) Combined heterogeneous catalysis and dark fermentation systems for the conversion of cellulose into biohydrogen. Biochemical Engineering Journal 101:209-219.
2. Gavilà L, Constantí M and Medina F (2015) D-lactic acid production from cellulose: dilute acid treatment of cellulose assisted by microwave followed by microbial fermentation. Cellulose 22:3089-3098.
3. Gavilà L, Güell E J, Maru B T, Medina F and Constantí M (2017) Combining catalytical and biological processes to transform cellulose into high value-added products. Physical Sciences Reviews DOI: 10.1515/psr-2017-0026.
4. Ye L, Zhou X, Hudari M.S, Li Z and Wu J (2013) Highly efficient production of L-lactic acid from Xylose by newly isolated Bacillus coagulans C106. Bioresource Technology 132:38-44.
5. Toor S S, Rosendahl L and Rudolf A (2011) Hydrothermal liquefaction of biomass: a review of subcritical water technologies. Energy 36:2328-2342.

Biography

Richard Ahorsu is currently a PhD student at the Department of Chemical Engineering, Rovira I Virgili University. His research is focused on transformation of biomass into value added chemicals. At the present, he adopted simple and cost efficient autohydrolysis technique to convert walnut shell into xylose and glucose followed by batch fermentation to obtain L-lactic acid. He obtained his Master's degree in Nanoscience, Materials and Processes in URV. During his Master's degree he intensively investigated hydrogen evolution through water splitting mechanism by employing electrospun photocatalyst.

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