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Article

A cleaner delignification of urban leaf waste biomass for bioethanol production, optimized by experimental design

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Abstract: This work presents a study of the conditions leading to improved delignification of urban forest waste typical of Buenos Aires. Particularly, the leaf waste of *Platanus acerifolia* has been studied. Delignification was accomplished by acid-oxidative digestion using acetic acid and 30% hydrogen peroxide 1:1. The effect of reaction time (30–90 min), temperature (60–90 °C), and solid loading (5–15 g solid/20g liquid) on delignification and solid fraction yield were studied. The process parameters were optimized using the Box-Behnken experimental design. The highest attained lignin removal efficiency was larger than 80%. The optimized conditions of delignification, while maximizing holocellulose yield, pointed to using the minimum temperature of the examined range. Analysis of variance on the solid fraction yield and the lignin removal suggested a linear model with a negative influence of the temperature on the yield. Furthermore, a negative effect of the solid loading and low effect of temperature and time was found on the degree of delignification. Then the temperature range was extended back to 60°C, and good results both of yield and delignification were obtained. Significant delignification with good yield attained at moderate temperature. Lignin removal was visualized using confocal laser scanning microscopy. The solid structure was slightly modified as judged from scanning electron microscopy.

Keywords: Biomass delignification; acid-oxidative hydrolysis; experimental design; urban waste

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1. Introduction

The urgency of accelerating development in a sustainable direction within a context of social demand for practices in compliance with standards of minimum environmental impact is reflected in the prerequisite for existing processes intensification and reduced risks of scaling up novel cleaner energy technologies based on renewable raw materials [1] while ensuring the continuity of energy supply. In this context, biomass is fundamental to a future energy sector adaptation and effectively mitigates climate change since energy production is the main source of carbon emissions [2]. Biofuels are crucial for reducing fossil-fuel dependency and greenhouse gas emissions. Bioethanol is a promising sustainable candidate for substituting gasoline [3]. Ethanol utilization in the world is available up to 20% blend in gas fuels.

Cellulosic ethanol presents an exciting and tangible but underdeveloped economic opportunity for ethanol producers, as the fuel's greater greenhouse gas (GHG) reductions