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Pretreatment of olive tree biomass with $FeCl_3$ prior enzymatic hydrolysis

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HIGHLIGHTS

- Olive tree biomass is a potential feedstock for the production of bioethanol.
- Pretreatment of olive tree biomass with $FeCl_3$ was assessed.
- Yields are better than those reported for this feedstock using other pretreatment methods.

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ABSTRACT

Olive tree biomass (OTB) is an agricultural residue which can be used as raw material for bioethanol production. OTB was pretreated with 0.05–0.275 M $FeCl_3$ solutions at 120–180 °C for 0–30 min. Enzymatic hydrolysis yields were used for assessing pretreatment performance. Optimum $FeCl_3$ pretreatment conditions were found to be 152.6 °C, 0.26 M $FeCl_3$ for 30 min. Under such conditions, 100% of hemicellulose was removed, and enzymatic hydrolysis of pretreated solids resulted in a yield of 36.6 g glucose/100 g of glucose in the raw material. Hemicellulosic sugar recovery in the prehydrolysate was 63.2%. Results compare well with those obtained by other pretreatment strategies on the same raw material, confirming $FeCl_3$ solutions as a new, feasible approach for bioethanol production.

1. Introduction

Lignocellulose materials are considered the most promising feedstock that can be transformed into renewable fuels and partially replace fossil fuels. Olive tree biomass (OTB) is one of the most abundant lignocellulose materials in Mediterranean countries, and olive tree cultivation is spreading all over the world (FAOSTAT, 2012). The conversion of OTB into ethanol has been proposed by Cara et al. (2008a) and Requejo et al. (2012a). Pruning of olive trees is performed every two years to eliminate unproductive branches and to increase fruit production.

This operation generates a huge amount of cheap and renewable lignocellulose material, which must be eliminated to prevent spread of diseases. From an environmental point of view, the transformation of OTB into bioethanol represents an alternative to other disposal methods such as direct burning.

The conversion process includes pretreatment, enzymatic hydrolysis to release fermentable sugars, fermentation, and distillation.

Pretreatment has been recognized as the key step for bioethanol production. The main objectives of pretreatment are removal of lignin and hemicellulose, reduction of the crystallinity of cellulose and increase in the porosity of the materials. The goal of pretreatment is to attain maximal fermentation yields and rates by improving the accessibility of enzymes to the cellulose structure without the formation of inhibitors for subsequent hydrolysis and fermentation processes (Gírio et al., 2010). It has been estimated that pretreatment is the most expensive single step of the conversion process, accounting for up to 20% of the total cost (Yang and Wyman, 2008).

Pretreatment of OTB has been carried out with dilute acid (Cara et al., 2008b), liquid hot water (Cara et al., 2007), organosolvolysis (Díaz et al., 2011), and steam explosion (Cara et al., 2008a). Dilute acid pretreatment produced relatively good results in terms of sugar yields after enzymatic hydrolysis of up to 75% (Cara et al., 2008b); however, the combination of dilute sulfuric acid solutions (less than 2% w/v) with temperatures of around 180–200 °C, re-

Abbreviations: OTB, olive tree biomass; WIS, water-insoluble solid; SR, solid recovery; CS_0, combined severity; CR_0, combined severity factor; R_0, severity factor; GR_S, glucose recovery in solid fraction; HSR_S, hemicellulosic sugars recovery in solid fraction; GR_L, glucose recovery in liquid fraction; HSR_L, hemicellulosic sugars recovery in liquid fraction; Y_{WIS}, enzymatic hydrolysis yield referred to glucose in the WIS; Y_{EH}, enzymatic hydrolysis yield referred to glucose in raw material.

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