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Evaluating pretreatment techniques for converting hazelnut husks to bioethanol

Yalçın Çöpür [a,*], Ayhan Tozluoglu [a], Melek Özkan [b]

[a] Düzce Üniversitesi Orman Fakültesi, Orman Endüstri Mühendisliği Bölümü, Konuralp Yerleşkesi, 81000 Düzce, Turkey
[b] Gebze Yüksek Teknoloji Enstitüsü, Çevre Mühendisliği Bölümü, Muallimköy Kampüsü, 41400 Gebze, Turkey

HIGHLIGHTS

- $NaBH_4$ delignified the highest amount of lignin (49.1%) from the husk structure.
- NaOH treated husk resulted in the highest xylan solubility (77.9%).
- NaOH treated husk had the highest glucan to glucose conversion (74.4%).
- NaOH treated husk the highest ethanol yield (52.6 g/kg husks).

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ABSTRACT

This study examined the suitability of husk waste for bioethanol production and compared pretreatment techniques with regard to their efficiencies. Results showed that 4% $NaBH_4$ (90 min) delignified the highest amount of lignin (49.1%) from the structure. The highest xylan solubility (77.9%) was observed when samples were treated with 4% NaOH for 90 min. Pretreatment with NaOH and $NaBH_4$, compared to H_2O_2 and H_2SO_4, resulted in selective delignification. The highest glucan to glucose conversion (74.4%) and the highest ethanol yield (52.6 g/kg husks) were observed for samples treated with 2% NaOH for 90 min.

1. Introduction

Almost 70% of the world's hazelnuts are grown in Turkey, which makes it a significant hazelnut producer. Based on this production, the amount of husk waste is estimated to be 200,000 ton/year (Midilli et al., 2000). This abundant agricultural waste has had no economic value to date and is usually burned in the fields, causing air pollution and soil erosion. In addition, the burning decreases the biological activity of the soil (Arslan and Saracoglu, 2010). Any possible industrial usage of hazelnut husks can be expected to yield economic as well as environmental dividends. The literature on using husk waste in industrial applications has been very limited. In earlier studies, the possible usage of husk waste in particleboard (Copur et al., 2007) and medium-density fiberboard (Copur et al., 2008) productions was examined. The usage of several agricultural residues in bioethanol production has been studied (Balat et al., 2008). On the other hand, no known effort has been made to utilize hazelnut husks as a resource for bioethanol production.

Like woody biomass, husk structure consists mainly of cellulose, hemicelluloses and lignin. Separation of individual lignocellulosic biomass components, such as cellulose or lignin, can increase their value dramatically. Cellulose, if not combined with lignin, can be converted into the biofuel ethanol through hydrolysis and subsequent fermentation (Lynam et al., 2012).

Therefore, several pretreatment techniques have been used in the process for efficient conversion of the structural carbohydrates to fermentable sugars. However, these applications remove some carbohydrates from the structure. Physical, physico-chemical, chemical and biological pretreatment methods have been utilized (Olsson and Hahn-Hägerdal, 1996), and all these techniques are expected to improve the efficiency of cellulose accessibility of hydrolytic enzymes. In addition, the ideal technique has to minimize the formation of degradation products because of their inhibitory effects on subsequent hydrolysis and fermentation processes. Ongoing studies seek to improve the efficiency of pretreatments by increasing the conversion rate for more economical ethanol production.

Several chemicals, including acids, alkalis, organic solvents, etc., are utilized in the pretreatment step of bioethanol production

* Corresponding author. Tel./fax: +90 380 5421137.
E-mail address: yalcincopur@duzce.edu.tr (Y. Çöpür).

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