Bioresource Technology 130 (2013) 211–217

Contents lists available at SciVerse ScienceDirect

Bioresource Technology

journal homepage: www.elsevier.com/locate/biortech

A feasibility study on the multistage process for the oxalic acid pretreatment of a lignocellulosic biomass using electrodialysis

Hong-Joo Lee [a], Sung Ju Ahn [a], Young-Jun Seo [b], Jae-Won Lee [b,c,*]

[a] Department of Bioenergy Science and Technology, Chonnam National University, 77 Yongbong-ro, Buk-gu, Gwangju 500-757, South Korea
[b] Department of Forest Products and Technology, Chonnam National University, 77 Yongbong-ro, Buk-gu, Gwangju 500-757, South Korea
[c] Bioenergy Research Center, Chonnam National University, Gwangju 500-757, South Korea

HIGHLIGHTS

- ▶ The feasibility of the recovery and reuse oxalic acid was investigated.
- ▶ The electrodialysis (ED) process was effective for recovery oxalic acid.
- ▶ ED process removed fermentation inhibitors without loss of fermentable sugar.
- ▶ Bioethanol productivity and yield increased up to three times by ED process.

ARTICLE INFO

Article history:
Received 4 September 2012
Received in revised form 7 December 2012
Accepted 9 December 2012
Available online 17 December 2012

Keywords:
Electrodialysis
Hydrolysate
Multistage process
Oxalic acid
Pretreament

ABSTRACT

The present study investigated the feasibility of the recovery and reuse oxalic acid in a multistage process for the pretreatment of a lignocellulosic biomass. Electrodialysis (ED), an electrochemical process using ion exchange membranes, was used to recover and reuse oxalic acid in the multistage process. The ED optimal condition for recover oxalic acid was potential of 10 V and pH 2.2 in synthetic solutions. The recovery efficiency of oxalic acid from hydrolysates reached 100% at potential of 10 V. The power consumption to treat 1 mol of oxalic acid was estimated to be 41.0 wh. At the same time, ethanol production increased up to 19 g/L in the ED-treated hydrolysate, corresponding to ethanol productivity of 0.27 g/L/h. It was clearly shown that bioethanol fermentation efficiency increased using the ED process, due to a small loss of fermentable sugar and a significantly high removal of inhibitory chemicals.

1. Introduction

Lignocellosic biomass is an attractive raw material for biofuel production, because of the availability of large quantities at low cost. Efficient utilization of the hemicelluloses and cellulose in a lignocellosic biomass offers an opportunity to greatly reduce the cost of bioethanol production, compared to the production cost from the first-generation biomass resources, such as sugar cane and corn (Cheng et al., 2008; Huang et al., 2008). In general, a lignocellulosic biomass is highly recalcitrant due to a lack of porosity, the presence of side chains, cellulose crystallinity, and high molecular weights. Prior to fermentation, it requires pretreatment to hydrolyze the biomass as feedstock (fermentable sugars or oligosaccharides) (FitzPatrick et al., 2010; Chew and Bhatia, 2008; Sarkar et al., 2012).

At present, most of the medium remaining after mushroom cultivation is utilized as compost. Since waste medium is a valuable resource for producing biofuels or biochemical products, concern for the bioconversion of waste mushroom medium to fermentable sugars has increased, as it constitutes one of the lignocellulosic biomass resources (Christopher et al., 2003; Lee et al., 2008). In general, the mushroom is cultivated artificially using plastic pots filled with medium material, such as lignocellulosic biomass and some additives. However, most of the medium remaining after mushroom cultivation has not been utilized, except for compost. Therefore, the utilization of this waste mushroom medium could be proposed as a valuable resources, such as bioethanol and other biochemical products. Waste mushroom medium is generated from mushroom cultivation, in which fungi produce hydrolytic and oxidative enzymes responsible for wood degradation. A pretreated waste mushroom medium could offer accelerated enzymatic hydrolysis, by using hydrothermal or acid-catalyst pretreatments (Sato et al., 2010).

* Corresponding author at: Department of Forest Products and Technology, Chonnam National University, 77 Yongbong-ro, Buk-gu, Gwangju 500-757, South Korea. Tel.: +82 62 530 2098; fax: +82 62 530 2099.
E-mail address: ljw43376@jnu.ac.kr (J.-W. Lee).

0960-8524/$ - see front matter © 2012 Elsevier Ltd. All rights reserved.
http://dx.doi.org/10.1016/j.biortech.2012.12.061