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Mixing of acid and base pretreated corncobs for improved production of reducing sugars and reduction in water use during neutralization

Ravichandra Potumarthi *[,1], Rama Raju Baadhe, Annapurna Jetty

Bio Engineering and Environmental Center (BEEC), Indian Institute of Chemical Technology (CSIR), Tarnaka, Hyderabad 500 607, India

HIGHLIGHTS

- We tested new approach for neutralization of pretreated corncobs.
- Water consumption for neutralization of acid/alkali-pretreated corncobs were reduced by 10-fold.
- Enzymatic hydrolysis released more sugars with acid and alkali treated corncobs than individually hydrolyzed.

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ABSTRACT

Pretreatment of biomass for bioethanol production makes it necessary to use large amounts of water for removing inhibitors and neutralization. In order to reduce water usage, separate batches of corncobs were hydrolyzed in 1 M NaOH and 0.05 M H_2SO_4, respectively, and the hydrolysis products were mixed to achieve a pH of 7. This approach lowered water usage by 10-fold compared with neutralization by distilled and recycling wash water. Mixing of the pretreated biomasses (121 °C, 20 min) increased release of reducing sugars during enzymatic hydrolysis with cellulases (38.49 FPU(IU)) produced by *Phanerochaete chrysosporium* NCIM 1106 by 2- and 15-fold compared with the sugars released from the unmixed NaOH- and H_2SO_4-treated corncobs, respectively. Enzymatic hydrolysis (EH, cell free extract) of the mixed material released 395.15 mg/ml of sugars during 48 h, slightly less than what was achieved by microbial hydrolysis (whole cell hydrolysis), 424.50 mg after 120 h.

1. Introduction

Large amounts of agricultural lignocellulosic waste materials are available and are potential sources for bioethanol production. Corncobs are a by-product of the corn (Maize) processing industry that are used as an animal feed, burned, or returned to the field (Inglett, 1970). India is producing nearly 21.4 million metric tons of corn annually (Annual Report, 2011); consequently abundant corncobs are available for bioethanol production as every 1 MT of maize produces 0.25–0.3 MT of cobs. Corncobs are composed 32.3–45.6% cellulose, 39.8% hemicelluloses and 6.7–13.9% lignin (Clark and Lathrop, 1953; Foley, 1978) and have an energy content of about 18.25–19.18 MJ/kg and an energy density of about 4960–5210 MJ/kg, approximately two times that of corn stover (17 and 2550 MJ/kg) and switchgrass (18 and 2500 MJ/kg). Its low lignin content makes corncobs a better biomass for production of bioethanol than corn stover and switchgrass. Much work has been carried out on pretreatment and hydrolysis of agricultural biomass using dilute acid, lime, microbial, ionic liquid, ammonia fiber expansion, oxalic acid, aqueous ammonia, individually and in combinations (Chen et al., 2010; Qiang et al., 2010; Rebecca et al., 2009; Yongming et al., 2006; Lee et al., 2010). Acid and alkali pretreatment processes run at pH 2–3 and 10–12 respectively, necessitation neutralization and use of large amounts of water prior to fermentation by yeast. The objective of the present study was to investigate the possibilities of combining acid- and alkali-pretreated corncobs to decrease the amount of water required.

2. Methods

2.1. Feedstock

Corncobs were obtained from local farms (Warangal, India) with 10–20% moisture content. Corncobs are milled and screened to obtain 3–5 mm-sized granules. All chemicals used were of analytical grade and purchased from Merck, Sigma Aldrich, and Himedia.

* Corresponding author. Tel.: +61 399053423; fax: +61 399054106.
E-mail addresses: ravichandra.potumarthi@monash.edu, pravichandra@gmail.com (R. Potumarthi).
[1] Present address: Bio Engineering Laboratory, Department of Chemical Engineering, Monash University, Clayton, Victoria 3800, Australia. Tel.: +61 399053423.

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