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Short Communication

Rapid analysis of barley straw before and after dilute sulfuric acid pretreatment by photoluminescence

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HIGHLIGHTS

- FI of pretreated barley straw was proportional to xylan content.
- The FI test could evaluate the effect of pretreatment on the barley straw.
- Photoluminescence analysis of biomass was rapid and effective.

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ABSTRACT

The fluorescence intensities (FIs) of raw and pretreated barley straws were measured by fluorescence microscopy, and the difference in the fluorescence intensity of barley straw before and after dilute acid pretreatment was analyzed by investigation of the major compounds of barley straw. The difference in fluorescence intensity was due to the difference in xylan content. Barley straw was pretreated using dilute sulfuric acid at various conditions and the correlation between the fluorescence intensity and glucose yield of barley straw was investigated. The coefficient of determination (R^2) of the correlation was found to be 72.28%. Also the calibration of fluorescence intensity with the xylan content was performed. In addition, the absorption and emission spectra of the raw and the pretreated barley straw were examined to verify the proposed method. The absorption and emission wave lengths were 550 nm and 665 nm, respectively.

1. Introduction

An understanding of biomass properties is important for the development of effective pretreatment steps, which are essential in biorefinery (Hames et al., 2003; Labbé et al., 2012). Biorefinery should include an appropriate pretreatment process for lignocellulosic biomass, which has a complex structure and heterogeneity. After pretreatment, a biomass should be characterized to determine the effectiveness and appropriateness of the pretreatment. Usually physical and chemical pretreatments are used to enhance enzyme accessibility (Alvira et al., 2010). During the pretreatment, a rigid biomass structure is denatured and structural barrier compounds are removed chemically. The fermentable sugar can then be liberated efficiently by saccharification enzymes (Hendriks and Zeeman, 2009).

Carbohydrates and lignin in a biomass before and after pretreatment can be analyzed by the NREL standard procedure (Sluiter et al., 2012), which, although precise, and needs to be manipulated carefully, demanding much time. Also pretreated biomasses have been analyzed using the X-ray diffractometer (XRD), which measures the exposed crystalline portion on the surface of a biomass (Segal et al., 1959). In addition, Fourier transform infrared (FT-IR) and near infrared (NIR) spectroscopy has been frequently used to confirm the presence of the glucosidic bond and other bonds (Kolar et al., 2000; Hames et al., 2003; Labbé et al., 2012). But these biomass analysis methods are inaccurate and indirect, although their procedures are relatively simple. A biomass after pretreatment in the biorefinery process must be analyzed to evaluate the appropriateness and effectiveness of the pretreatment rapidly. Thus, a novel biomass analysis method which is fast, accurate and low cost is needed.

Photoluminescence (PL) is the phenomenon where a substance absorbs photons. Fluorescence is a PL phenomenon where electron

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