Power model for enzymatic hydrolysis of coconut coir with chemical pretreatment

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Abstract:

Coconut coir, that contains cellulose, hemicellulose, lignin, and some other extractive compounds, is classified as complex lignocellulosic material. Glucose from coconut coir can be used as fermentation substrate after enzymatic hydrolysis. Lignin content from the coconut coir will act as an inhibitor in this hydrolysis process. Therefore, a pretreatment process is needed to enhance the hydrolysis of cellulose. It has been found out that; pretreatment methods have significant impact on production efficiency of ethanol from biomass. Some of the most promising pretreatment methods require the application of chemicals such as alkali, acids, salts, oxidants, and solvents.[1] In this research, chemical pretretment, i.e. dilute acid and alkaline pretreatment were done prior to enzymatic hydrolisis of coconut coir. Previous study observed that the the best pretreatment was at 1.5% sulfuric acid concentration and 100 °C for dilute acid pretreatment[2] and 11% NaOH and 100 °C for alkaline pretreatment.[3] Here, pretreatment was done at 121 °C and 11% NaOH; and 105 °C at 1.5% sulfuric acid. The objective of this research is to compare the glucose as a product of hydrolysis for these two types of chemical pretreatment. The kinetic parameters due to simple power model were then obtained.

1. Introduction

Fuel-ethanol production from sugar-cane, beet and corn may be a problem in the near future due to the food competition in the use of these materials for bioenergy production.[4] Therefore, conversion of abundant lignocellulosic biomass to ethanol as a bio- fuel presents an important opportunity to improve energy security, reduce greenhouse gas emission, reduce the trade deficit, and improve price stability.[5]

Recently, several ways of utilizing biomass and associated waste for energy production in different forms e.g., bio-ethanol, biogas, bio-diesel, pyrolytic bio-oil, etc. have been envisaged thoroughly by researchers around the world.[6,7,8]

Coconut coir (Figure 1) is lignocellulosic biomass. It is a natural fibre extracted from the husk of coconut and used in products such as floor mats, doormats, brushes, mattresses, etc. Coir is the fibrous material found between the hard, internal shell and the outer coat of a coconut. As lignocellulosic biomass, coconut coir can produce second generation bioethanol in three main steps: pretreatment, hydrolysis, and fermentation.

Pretreatment involves the use of physical processes (e.g., size reduction, steaming/boiling, ultrasonication, and popping), chemical methods (e.g., acids, bases, salts, and solvents), physicochemical processes (e.g., liquid hot water and ammonium fibre explosion or AFEX), biological methods (e.g., white-rot/brown-rot fungi and bacteria), and several combinations thereof to fractionate the lignocellulose into its components.[1]

Chemical pretreatment for coconut coir had been studied previously.[2,3] It was found that the best pretreatment was at 1.5% sulfuric acid concentration, 100 °C for dilute acid pretreatment[2] and 11% NaOH, 100 °C for alkaline pretreatment.[3]

Power model was used to represent kinetic of the coconut coir batch enzymatic