Fermentability of the Water-Soluble Portion Obtained by Hot-Compressed Water Treatment of Lignocellulosics

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1. INTRODUCTION

Recently, some studies on the supercritical water treatment for lignocellulosics have been carried out to obtain the fermentable water-soluble (WS) portion. However, the WS portion obtained contains not only fermentable sugars but also some furan compounds such as furfural and 5-hydroxymethylfurfural, which are formed by the degradation of sugars, and various phenolic compounds, which are formed by degradation of lignin. Although the quantities of these compounds in the WS portion are very little, these compounds inhibit the ethanol fermentation of the sugars by the microorganisms. The object in this study, therefore, is to improve the ethanol fermentability of the WS portion.

2. MATERIALS AND METHODS

Japanese cedar (*Cryptomeria japonica*) or Japanese beech (*Fagus crenata*) was treated using batch-type biomass conversion system with a 5mL volume reaction vessel made of inconel-625. Water was fed with 150mg of wood flour (passed through 80 μm mesh) to this reaction vessel, and then it was quickly heated by immersing it into the molten tin bath preheated at 400℃ for 8s. The reaction vessel was then immersed in water bath to stop the reaction. After the treatments, the WS portion was retrieved by filtration.

Western red cedar (*Thuja plicata* D. Don) flours were treated under nitrogen at a heating rate of 4℃/min and maintained at the designated temperature for 1h in a range between 400 and 900℃ to prepare various types of wood charcoals.

To the WS portion, the wood charcoal which was prepared at various temperatures was added at a loading of 7wt% charcoal over the WS portion. The WS portion with the wood charcoal was then stirred for 10min at room temperature. Subsequently, the wood charcoal was separated from the WS portion by filtration.

The fermentation test on the WS portions untreated and treated with wood charcoal was carried out with *Saccharomyces cerevisiae, Candida shehatae, Pachysolen tannophilus and Pichia stipitis.*

3. RESULTS AND DISCUSSION

From the fermentation test on the untreated WS portion from Japanese cedar, ethanol could not be produced with any yeast. Through HPLC analysis on the WS portion, furfural, 5-HMF, guaiacol, vanillin, acetoguaiacone and coniferyl aldehyde were identified. These compounds, which are thought to be inhibitors for the ethanol fermentation, could be removed by wood charcoal treatment. Especially in the wood charcoal prepared above 700℃, these compounds were adsorbed completely and not detected any more. On the other hand, fermentable sugars such as glucose, fructose, mannose, galactose and xylose were not removed in any wood charcoal treatments.

It took only 6h for fermentation of the WS portion after the wood charcoal treatment with *Saccharomyces cerevisiae*, although the fermentation occurred after 50-140h with *Candida shehatae, Pachysolen tannophilus* and *Pichia stipitis*. The highest ethanol production was attained with *Saccharomyces cerevisiae.*

In the WS portion from Japanese beech, the similar results were obtained. However, the produced ethanol in the fermentation with *Saccharomyces cerevisiae* was less compared to Japanese cedar because *Saccharomyces cerevisiae* can not ferment xylose which is contained more in the WS portion from Japanese beech than Japanese cedar. These results revealed that the wood charcoal treatment is effective in detoxifying the WS portion and enhancing its fermentability.