論　文　の　要　旨

題目 Production of glucose from agricultural waste using hydrothermal pretreatment and enzymatic hydrolysis: Study on enzymes, reaction medium, and effect of feedstock structural linkage
（水熱前処理と酵素加水分解を用いた農業残渣からのグルコース生産－酵素、反応媒体、原料構成物間結合の効果に関する研究）

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Cellulose from agriculture wastes biomass have been an attractive resource of glucose for various purposes including bioethanol production because it can be hydrolyzed using enzymes into glucose, and subsequently fermented using yeast into ethanol. Cellulose structure is attached to hemicellulose and lignin together called lignocellulose. Therefore, hemicellulose and lignin are the barriers to be removed through a pretreatment prior to enzymatic hydrolysis. Thus, pretreatment has been seen as a determinant factor. Among various techniques, hydrothermal pretreatment uses water as the reaction medium so it has been seen as a safe and environmentally friendly process. To create a successful bioethanol production from lignocellulosic biomass using this technology, the process should be designed with ensuring its effectiveness, efficiency and sustainability.

The enzymatic hydrolysis essentially evaluates the effectiveness of pretreatment. The most common technique of enzymatic hydrolysis is using enzyme cellulase complex obtained from fungi which convert cellulose into glucose. However, it is commonly lacking of one component called ß-glucosidase. Therefore, addition of ß-glucosidase is necessary to enhance the hydrolysis. As consequence, the expression of this addition effect is required to select the best condition for an effective hydrolysis. In this study, the simple equation to express the accessory enzyme addition effect on cellulose hydrolysis using commercial cellulase complex was developed which is useful for determining the optimum amounts of enzyme addition required for cellulose hydrolysis.

Beside using the optimum amount of enzymes for enzymatic hydrolysis, the water for reaction medium in hydrothermal pretreatment should not be used excessively to ensure its sustainability. In fact, to enhance the reaction, commercial catalysts are commonly added in hydrothermal pretreatment which will add the cost for production. Thus, it is necessary to find an alternative for the reaction medium and commercial catalysts that is low cost and available onsite. In this study, the potential use of wastewater to replace freshwater and commercial catalyst for hydrothermal pretreatment of agriculture wastes was evaluated. The use of wastewater can be one of strategies to create an efficient process.

To understand the behavior of cellulose from lignocellulosic biomass in hydrothermal pretreatment, model compounds mixtures which are the isolated cellulose, hemicellulose and lignin from plants are often used as the feedstock in various studies. However unlike in the actual biomass, in model compound mixtures the structural cross-link of cellulose, hemicellulose and lignin is absent. The effect of this structural cross-link need to be clarified. Therefore, the behavior comparison between actual lignocellulosic biomass with artificial mixtures in hydrothermal pretreatment was carried out. Moreover, the mechanism of lignocellulose biomass behavior in hydrothermal pretreatment was proposed which will be useful for designing a successful bioethanol production.