Enhancement of biomass hydrolysis by Fenton oxadation-hydrothermal treatment and analysis of chemical component by near infrared spectroscopy

So-Yeon Jeong [(1)], Jae-Won Lee [(2)]

[(1)(2)] Department of Forest Products and Technology, College of Agriculture and Life Sciences, Chonnam National University, Gwang-ju 500-757, Republic of Korea

1. Introduction – Biomass feedstocks are a sustainable resource required for growth of renewable biobased chemicals production. Pretreatment of biomass requires a large amount of energy, and there is a need to maintain a balance between efficiency improvement and cost for produce of environmentally-friendly high value-added products from biomass. Fenton oxidation (FO) which is environmentally friendly system for the degradation of biomass is used to improve the effect of pretreatment [1].The high performance liquid chromatography (HPLC) analysis of acid hydrolysates that come from biomass pretreatment is time consuming and expensive. NIR techniques are rapid, nondestructive, environmentally friendly and do not require sample preparation or the use of chemical reagents compare to wet chemistry method [2]. In this study, we investigated enhancement of biomass hydrolysis by Fenton oxidation-hydrothermal treatment and performed analysis of hydrolysate by using NIR.

2. Experimental – Acacia (*Acacia mangium),* Yellow poplar (*Liriodendron tulipifera*) and Eucalyptus (*Eucalyptus globulus*) chips were used as raw material. The chips were ground and then screened to a 20–80 mesh size. The molar ratio of the Fenton reagent ($FeSO_4 \cdot 7H_2O$ and H_2O_2) was 1:25, and the fenton oxidation time was 1 h. The hydrothermal treatment (HT) of the biomass was carried out in an EMS reactor (Mode EMV-HT/HP 600, Gyeonggi-do, Korea). The reaction temperature and time were 160-200°C and 5-40 min, respectively. The sugar and inhibitor concentrations in the hydrolysate were determined using HPLC (Waters 2695 system; Alliance, USA), outfitted with an Aminex HPX-87H column (300×7.8 mm, Bio-Rad, Hercules, USA), and a refractive index detector (Waters 2414 system; Alliance, USA). The NIR spectra were measured using an IR spectrophotometer (IR Prestige-21, Shimadzu, Japan). The spectrum covered a range of 10,000–4000 with a spectral resolution of 4 cm^{-1} and 32 scans per sample.

3. Results and Discussion - The sugars and inhibitors analyses in the hydrolysate obtained by hydrothermal pretreatment are shown in Fig. 1. FO-treated biomass produced more sugars and inhibitors than raw material during hydrothermal treatment.

Fig. 1. Biomass degradation products in the hydrolysate during hydrothermal treatment (a) raw material-hydrothermal treatment (R-HT) and (b) Fenton oxidation-hydrothermal treatment (FO-HT).

4. References

[1] G. Banerjee, S. Car, J.S. Scott-Craig, D.B. Hodge, J.D. Walton, Biotechnol. Biofuels., (2011) p. 4.
[2] X. Feng, W. Donghai, Bioresour. Technol., 147 , (2013) p. 293