MICROWAVE ENHANCED ENZYMATIC BIODEGRADABILITY OF CELLULOSIC BIOMASS

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Abstract

In the process of bioethanol production, the enzymatic degradation of lignocellulosic biomass presents and effective and eco-friendly alternative to conventional methods, however, due to the rigid molecular structure of the cellulose fibers, the enzymatic hydrolysis usually requires one or more pre-treatment steps. Based on several scientific researches, physicochemical pre-treatment methods – such as microwave/ultrasound irradiation; alkaline/acid fracturing – represent a promising direction to increase the efficiency of cellulose degradation when combined with a subsequent, enzyme-based hydrolytic step.

The aim of our research was to investigate the enzymatic biodegradation of lignocellulose-containing biomass, and the effects of standalone and alkaline/acid-combined microwave irradiation on the process of the hydrolysis. Mixture of different parts of by-product tobacco plants in an aqueous suspension of 10 (m/m)% were used for the experiments. Microwave irradiation was applied at two different levels of energy that corresponds to energy density values of 9 kJ/g_{DM} and 4.5 kJ/g_{DM}, each with a power intensity of 250W and 500W as well. For the acid- and alkaline-combined MW pre-treatments the pH was set to pH=2.0 and pH=11.0, respectively. The 60-hours-long enzymatic hydrolysis which followed the pre-treatment steps was carried out with using a mixture of two different enzymes: cellulase from *Trichoderma reesei* and cellobiase from *Aspergillus niger* with a specific activity of 700 U/g and 250 U/g, respectively. Control samples did not come through any pre-treatment processes before the biodegradation. The reducing sugar (RS) content – the end-product of the cellulolysis – was measured with DNSA-based spectrophotometric method.

Our results revealed that even the standalone MW irradiation could increase the final end-product concentration compared to the control samples, and the highest RS concentration could be achieved when the MW operational parameters were set to 500W and 3 minutes (cf. 72±3 mg/g_{DM} vs. 44±2 mg/g_{DM}). When applying an acidic medium to the samples, the final RS yield was maximum when MW irradiation was applied at 500W and lasted for 3 minutes, resulting in 112±6 mg/g_{DM} final RS concentration, however when setting the pH to alkaline range (pH=11), using a lower (250W) power intensity was more effective – with a 250W and 3 minutes-long MW treatment, the final end-product content at the end of the hydrolytic process was almost 160 mg/g_{DM}, which indicates a nearly fourfold increment, compared to the control samples.

Key words: microwave, lignocellulose, biomass, pre-treatment

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