Optimization of acid sulfite pretreatment in the enzymatic hydrolysis of Cytisus striatus

Álvaro VAZ[1], Tânia GOMES[1], Rogério SIMÕES[1]

[1] *Universidade da Beira Interior, Portugal*

Ethanol production from lignocellulosic material includes three major steps: biomass pretreatment, which fragments the lignocellulosic matrix to facilitate the enzymes access to the substrate; hydrolysis, where the polysaccharides are converted into fermentable sugars (e.g. glucose and xylose) [1]; and finally, fermentation that produces ethanol or other biologically based chemicals (e.g. lactic acid, succinic acid) [2]. The aim of the present work was to study the effect of some operative variables of the pretreatment stage, namely sodium hydrogen sulfite and sulfuric acid loadings, temperature and time, on the release of sugars in the enzymatic hydrolysis of Cytisus striatus, performed applying a Novozymes® cocktail, with fixed charges and operating conditions. Wood branches were chipped and submitted to different reaction conditions, with a central composite experimental design 2^4+star, exploring the following variables: sulfuric acid charge (0-3%, on wood), sodium bisulfite charge (0-4 %, on wood), maximum temperature (150-190ºC) and time at maximum temperature (0-30 minutes). After pretreatment, the acid hydrolysates were recovered and the solid residues were mechanically disintegrated and thereafter subjected to enzymatic hydrolysis with an enzymatic cocktail from Novozymes®. Sugars and by-products released in the sulfite pretreatment and enzymatic treatment hydrolysates were analyzed by HPLC. The percentage of material released in the acid hydrolysates was between 7 and 29.1%. Temperature and sulfuric acid load were the most important tested variables. The inhibition products represented less than 0.9% of the initial wood mass, even for the most severe reaction conditions. Enzymatic hydrolysis of polysaccharides on solid residues resulted in conversions from 6.0 to 68.9%, depending on the reaction conditions used in biomass pretreatment with sulfite and sulfuric acid. The rate of sugars release proved to be high at the beginning, gradually decreasing with contact time. The experimental data analysis using Statgraphics®Plus5 enabled us to obtain correlation expressions and conclude that all study variables influence this phase of the process, mainly temperature and sulfuric acid load. For a given sulfite load, more acidic conditions led to higher sugar release and greater fragmentation of the material, but also higher production of degradation products; moderate sodium bisulfite (1%) and sulfuric acid (2.25%) loads released practically all hemicelluloses in the raw material.

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