Evaluation of cold plasma treatment for enhanced enzymatic hydrolysis of waste stream

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The fruit processing and wine-making industry are important industrial sectors in the EU, generating various side streams including stalks. The main components of stalks are lignin, cellulose, hemicellulose and protein. Bioconversion of these waste streams into value-added products and biopolymers could pave the way towards a circular bioeconomy and environmental sustainability (Ioannidou *et al.*, 2022). Lignin is closely associated with cellulose and hemicellulose impeding their efficient conversion into C5 and C6 sugars. To overcome the recalcitrant structure of biomass, pretreatment is an essential step that improves the accessibility of enzymes to carbohydrates. Cold plasma treatment with atmospheric air supply could improve cellulose and hemicellulose enzymatic hydrolysis (Ravindran *et al.,* 2019).

The main objective of this work is the utilisation of cold plasma as an alternative and environmentally friendly method for fruit and grape stalks pretreatment aiming to increase their enzymatic hydrolysis. The composition of stalks, such as cellulose, hemicellulose and lignin, was initially determined. The solids were subjected to plasma treatment. The influence of the air flow rate, the duration of the treatment, the voltage and the duty cycle were investigated in order to assess the removal of lignin, hemicellulose and cellulose during plasma treatment. The effectiveness of the process was also evaluated by enzymatic hydrolysis of the pretreated biomass with commercial enzyme preparations, such as cellulase (20 FPU/g pretreated biomass) and β-glucosidase (80 U/g pretreated biomass). All hydrolysis experiments were conducted at 50ºC with 100 g/L initial solid concentration under mechanical stirring. The release of fermentable sugars was measured, comparing the samples obtained with and without plasma pretreatment. Enzymatic hydrolysis was also evaluated utilizing deionized water and liquid obtained after plasma treatment.

The stalks contained mainly 25.9% lignin, 23.1% cellulose, 16.7% hemicellulose, 8.7% protein and 9.7% lipids. The hydrolysis of the solids obtained after plasma treatment resulted in cellulose hydrolysis yield up to 80%. The results obtained in this work indicate that cold plasma is a promising pretreatment method that could efficiently replace the environmental harmful and costly conventional pretreatment methods.

References

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