Alkaline pretreatments of agricultural residues for ethanol production

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INTRODUCTION

Residues of olive trees pruning need to be removed every year so as not to compromise the health of the fruit (olives). However, at present, despite disposal costs, there is no monetization this waste.

Therefore, the use of this waste for the production of cellulosic ethanol could be quite promising. In the present work, the optimization of dilute acid pretreatment conditions of olive tree pruning was studied.

A fundamental step in the production of ethanol from lignocellulosic materials is the improvement of the carbohydrates accessibility to enzymatic hydrolysis, which can be performed with physic-chemical pretreatments

MATERIALS AND METHODS

- In this work, two alkaline pretreatments were tested. The first pretreatment was carried out with sodium hydroxide (residence time: 20 - 120 minutes, temperature: 40 - 140ºC and NaOH concentration: 0,31 - 6,19% w/w and the second with sodium hydroxide and hydrogen peroxide (time: 45 minutes, temperature: 40 -140ºC, NaOH concentration: 0,31 - 6,19% w/w and H2O2 concentration: 0,31 - 6,19% w/w)

- The pretreatments were carried out in a 200mL steel reactors immersed in a heating poly(ethylene)glycol (PEG) 400 bath and agitated under controlled temperatures and a total of 34 runs with different combinations of the variables were used according to a central composite rotable design (CCDR) generated using Design Expert. .

- Individual sugars were analyzed by HPLC according to the Standard Biomass Analytical Procedures from the National Renewable Energy Laboratory (NREL/TP-510-42623). Lignin was evaluated after precipitation from the hidrolyzates by acidification. The soluble lignin was determined by measuring the absorvance at 240nm.

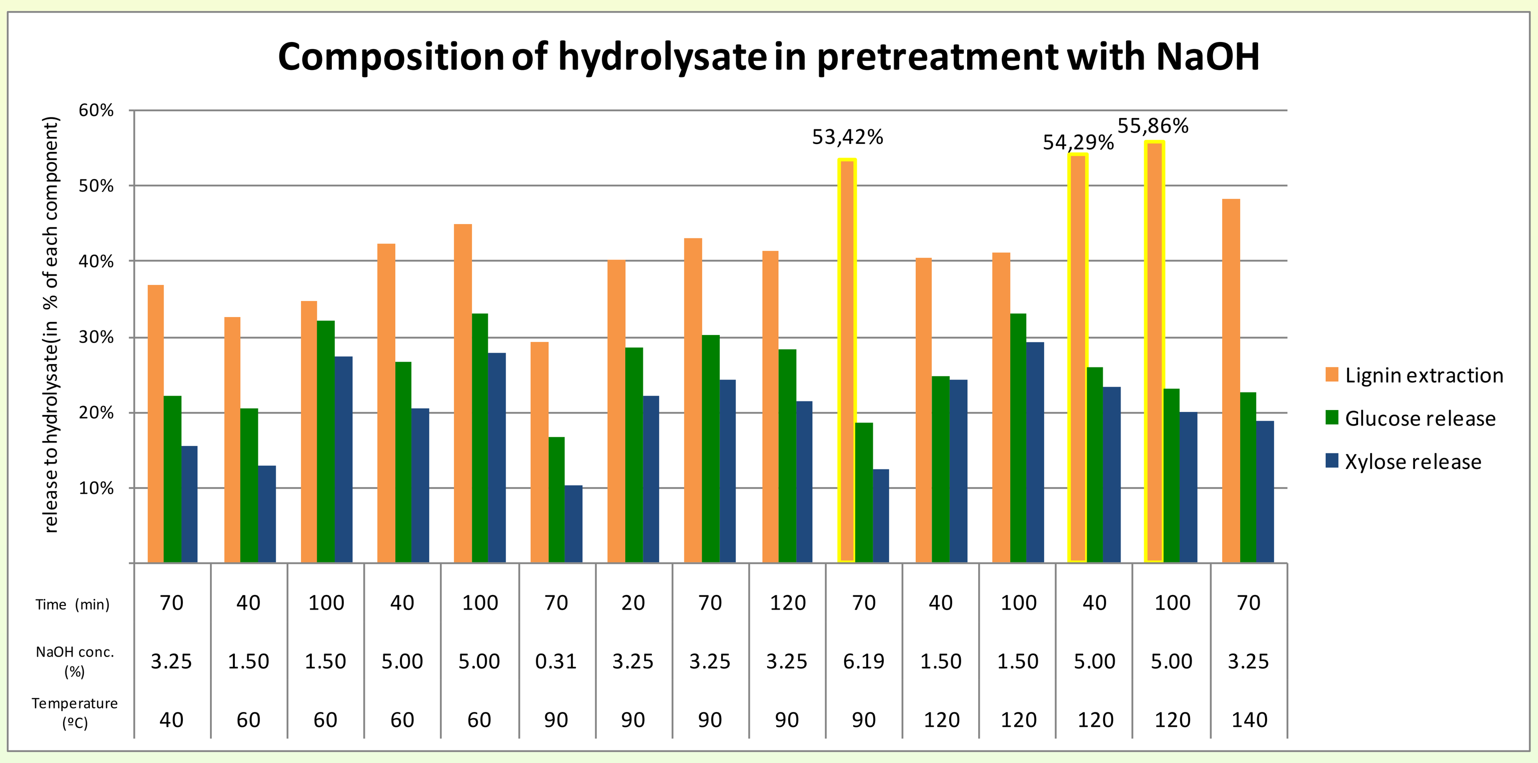
RESULTS

Chemical analysis

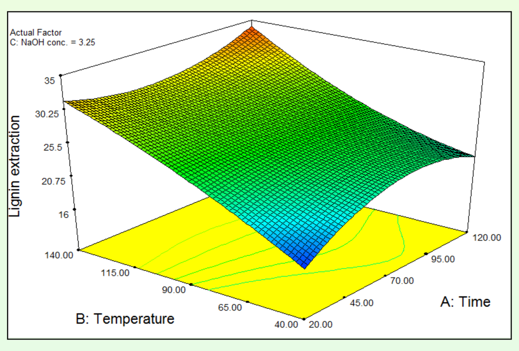
- The composition of the raw material was determined on extractives-free biomass samples, after a two extraction step

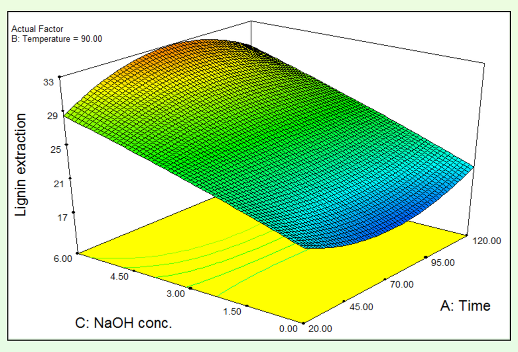
Composition	% Dry Matter
Glucose	33,59 ± 2,25
Xylose	13,11 ± 1,02
Arabinose	4,55 ± 0,20
Extractives	15,84 ± 0,44
Acid-insoluble lignin	18,07 ± 0,33
Acid- soluble lignin	6,89 ± 0,05
Acetyl groups	5,90 ± 1,85
Ash	3,76 ± 0,01

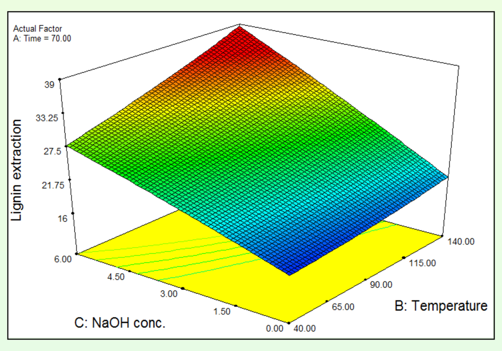
- In three test conditions it was possible to remove more than 50% of the lignin in the biomass. The average release rate of sugars to the hydrolysate was about 25% of sugars in the sample



- The removal of lignin is influenced primarily by the concentration of NaOH followed by temperature.

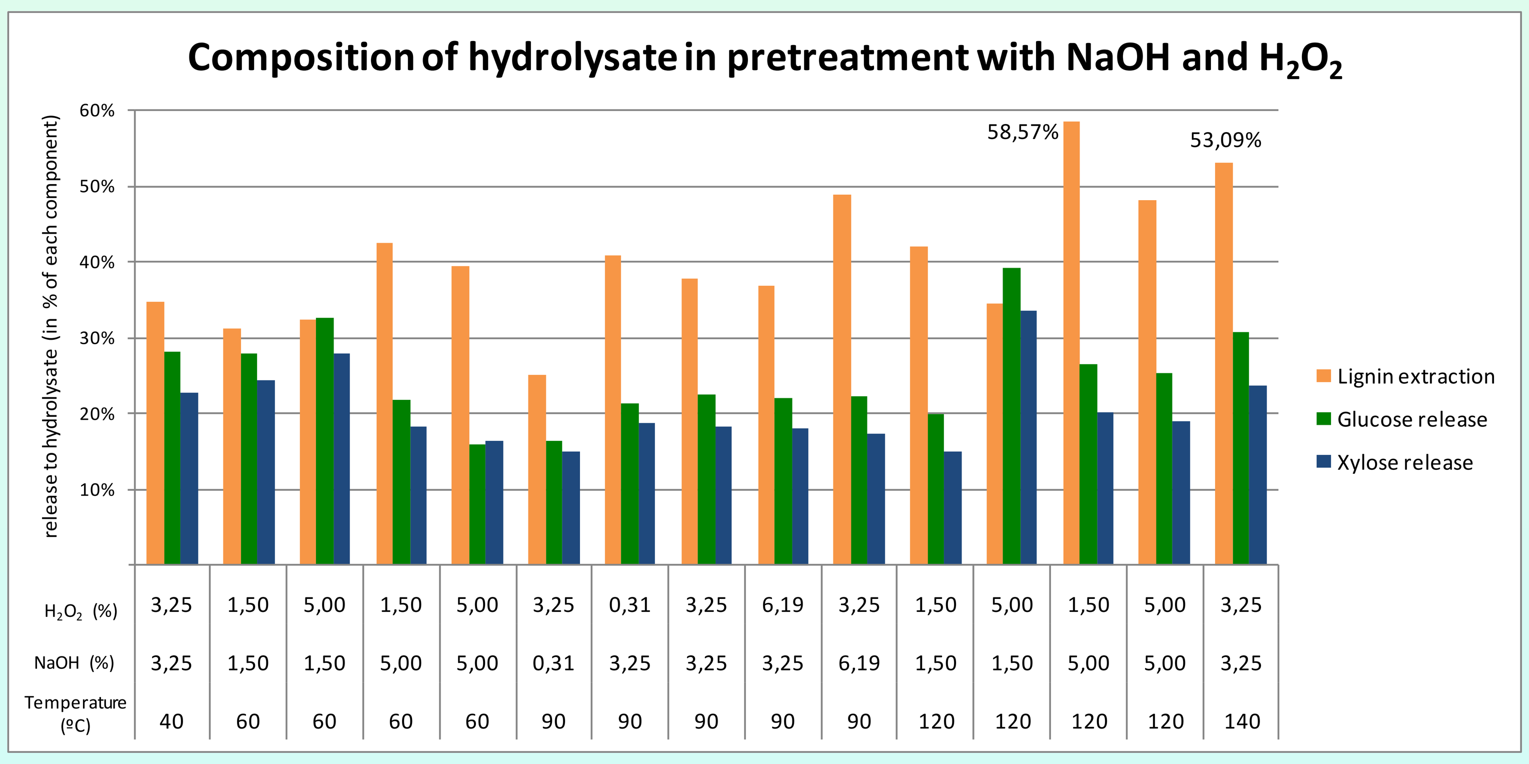




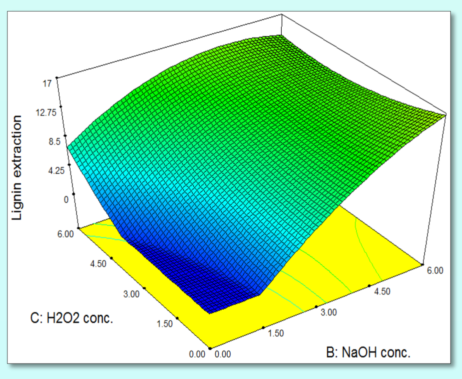


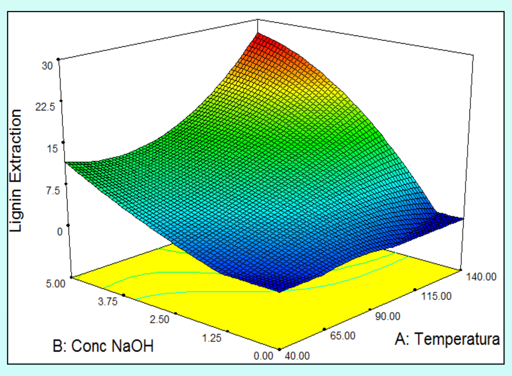
- The addition of H_2O_2 in pretreatment with NaOH only increases lignin removal rates in tests with temperatures exceeding 90° C and in which the concentrations of H_2O_2 are not higher than the concentration of NaOH..

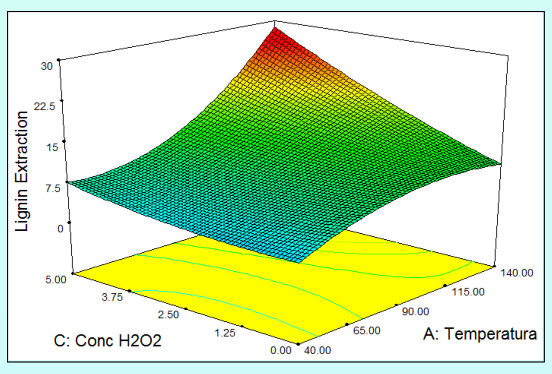
- With the exception of intermediate temperature (90 ºC), the addition of H_2O_2 causes a greater release of sugars to the hydrolysate, in trials where its concentration is higher than the concentration of NaOH



- The increase in the concentration of NaOH and H_2O_2 with temperature causes an increase in the removal of lignin. This effect acquires greater visibility above 120º C.







CONCLUSIONS

➡ The maximum value for lignin removal in pretreatment with NaOH was 55.86% (% lignin in biomass) in tests conducted with residence times of 100 minutes, temperature of 120º C and NaOH concentration of 5.00%.

➡ Under these conditions, the percentage of lost sugars in the hydrolysate was 23.41 % (% sugars in biomass). The regression equation obtained from the model, using removal lignin as response, indicating an R^2 value of 0.96.

➡ The maximum value for lignin removal in pretreatment with NaOH and H_2O_2 was 58.57% (% lignin in biomass) in tests conducted with temperature of 120º C, NaOH concentration of 5,00% and H_2O_2 concentration of 1,50%.

➡ Under these conditions, the percentage of lost sugars in the hydrolysate was 25.04% (% sugars in biomass). The regression equation obtained from the model, using removal lignin as response, indicating an R^2 value of 0.98.

Acknowledgements
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