Olive trees pruning as a potential source for 2nd generation ethanol production

N. Pedro[1,2], A. P. Duarte[3]

1ESA -IPCB – Escola Superior Agrária, Instituto Politécnico de Castelo Branco, Quinta da Senhora de Mércules, 6001-909 Castelo Branco, Portugal

2 Research Unit of Textile and Paper Materials, University of Beira Interior, Rua Marquês d'Ávila e Bolama, 6201-001 Covilhã, Portugal

3CICS-UBI - Health Sciences Research Centre, University of Beira Interior, Av. Infante D. Henrique, 6200-506 Covilhã, Portugal

INTRODUCTION

Olive tree wood is an agricultural residue largely available in Portugal. It is estimated that the amount of material annually produced from olive trees pruning, can be up to 250 000 tonnes. This wood resulting from pruning is a material rich in cellulose and hemicelluloses which can be recovered for the production of 2nd generation ethanol through its use as feedstock. Pretreatment is a crucial step in bioconversion of lignocellulosics to bioethanol, in order to improve the carbohydrates accessibility to enzymatic attack.

In the present work, the optimization of dilute acid pretreatment conditions of olive tree pruning was studied.

MATERIALS AND METHODS

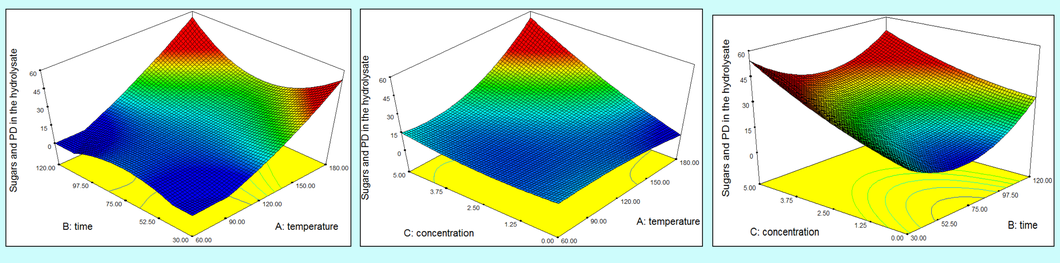
- The composition of the raw material was determined on extractives-free biomass samples, HPLC according to the Standard Biomass Analytical Procedures from the National Renewable Energy Laboratory (NREL).
- Batch reactions were carried out under different operating conditions and a total of 34 runs with different combinations of the variables were performed according to a central composite rotable design (CCDR) generated using Design Expert software.
- The operating conditions were temperature (60 – 180 ºC), residence time (30 – 120 min) and sulphuric acid concentration (0.5 – 5% w/w). The carbohydrates and degradation products in the pre-treatments hydrolysates were determined in terms of individual sugars by HPLC, according to the Standard Biomass Analytical Procedures from NREL.

RESULTS

- Raw Material Chemical Composition

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

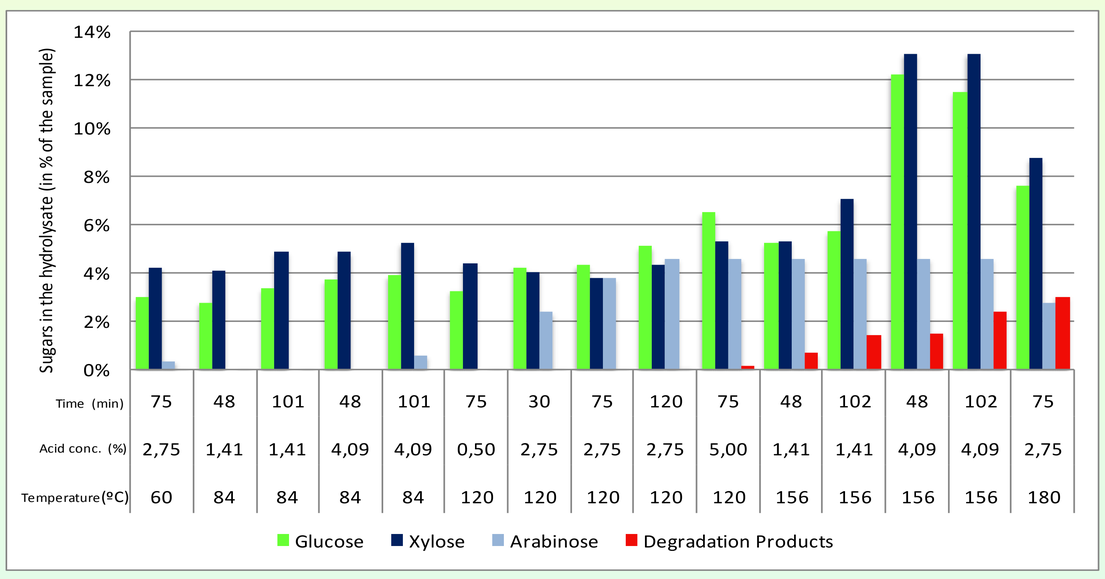
- The relationship between the response and significant variables of the pretreatment is presented in the following graphics



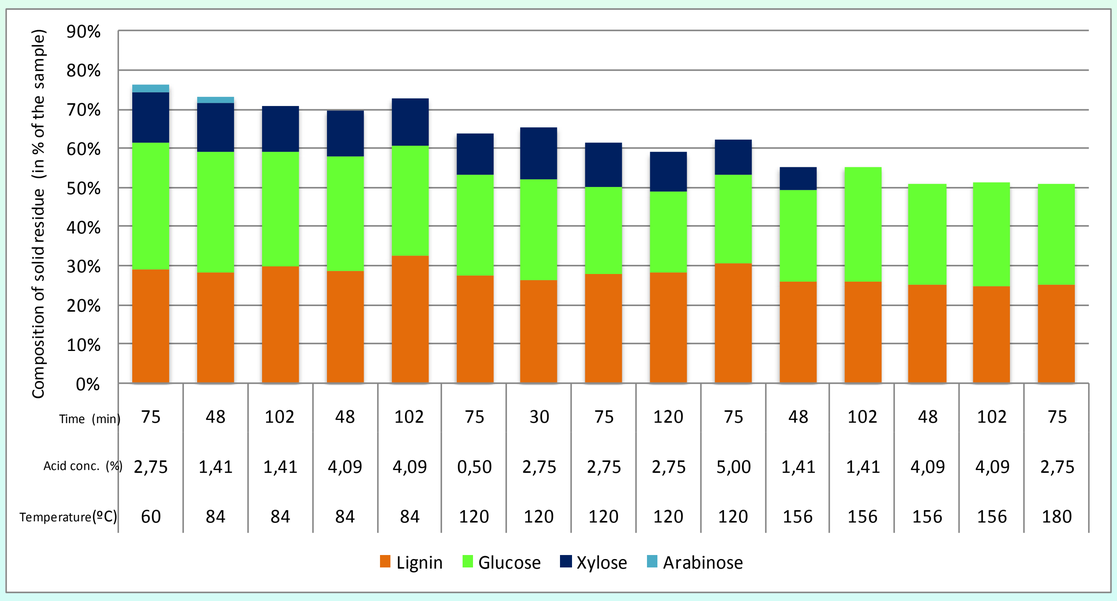
- It can be observed that temperature and acid concentration are the most significant factors in the explanation of sugars and degradation products release to the hydrolysate (Temperature x H_2SO_4 Concentration < 0.0001).
- The equation Eq1 obtained from the model (R^2 value: 0.95), describes the correlation between the significant variables and the carbohydrates and degradation products released during the pretreatment:

$$Eq1 = -91{,}94282 + 0{,}88607 \times temp. + 2{,}85873 \times time + 1{,}55324 \times conc. - 0{,}023847 \times temp. \times time - 0{,}13317 \times temp. \times conc. + 0{,}031524 \times time \times conc - 8{,}4283 \times 10^{-5} \times temp.^2 - 0{,}020762 \times time^2 + 0{,}61561 \times conc^2 - 4{,}26244 \times 10^{-4} \times temp. \times time \times conc. - 1{,}17615 \times 10^{-5} \times temp.^2 \times time + 1{,}02652 \times 10^{-3} \times temp.^2 \times conc. + 1{,}88243 \times 10^{-4} \times temp. \times time^2$$

- The largest release of sugars to the hydrolysate occured with a temperature of 156 ºC and an acid concentration of 4.09%.



- More severe pretreatments (4.09% acid concentration/156 ºC and 2.75%/ 180 ºC) gave rise to solid residues with about half the weight of the initial sample, being composed mainly by lignin and glucose



CONCLUSIONS

➡ The chemical characterization of biomass showed values that allowed presuming their potential as bioethanol feedstock.

➡ The results showed that temperature and acid concentration were the variables showing the greatest significance.

➡ The maximum releasing of sugars was obtained when reaction was carried out during 48 minutes at 156ºC with 4.09% of acid concentration. Most severe pretreatments gave rise to complete hydrolysis of hemicelluloses.

➡ The results obtained in this preliminary work demonstrate that this agricultural residue could be a promising renewable raw material for 2nd generation ethanol production.

Acknowledgements

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