Improvement of the enzymatic hydrolysis of acid-pretreated olive stones by organosolv pretreatment

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INTRODUCTION

Lignocellulosic biomass, due to its composition rich in cellulose, hemicellulose and lignin, is of great interest for obtaining value-added products; these processes can be included within the concept of biorefinery. The waste obtained from olive cultivation is an example of these materials; specifically this work is focused on the use of olive stones (OS). The OS are located in the olive oil mills and olive pomace mills, as a waste of the process of olive oil production.

OBJECTIVE

Maximise the use of the sugars contained in the olive stone in two stages:
- First acidic stage to solubilise hemicellulose.
- Second organosolv stage to improve the cellulose solubilisation yields in enzymatic hydrolysis.

Keywords: Olive stones, biorefinery, enzymatic hydrolysis, organosolv pretreatment

MATERIALS AND METHODS

OLIVE STONES

ACID HYDROLYSIS

Box-Behnken design
Time → 60 minutes
Temperature → 120-130 °C
Biomass loading → 20-60%
H_2SO_4 concentration → 7.5-17.5% (g acid/100 g biomass)

Solid (cellulose + lignin)

Liquid (hemicellulose)

ORGANOSOLV DELIGNIFICATION

Ethanol:water → 50:50 (w/w)
Biomass loading → 1/6 solid/liquid (w/w)
Temperature → 190 °C
Time → 0-150 min

Solid (delignified)

ENZYMATIC HYDROLYSIS

Cellic CteC2
- 15 FPU/g substracte
- 5% solids
- 50 ºC, 150 rpm, 72min

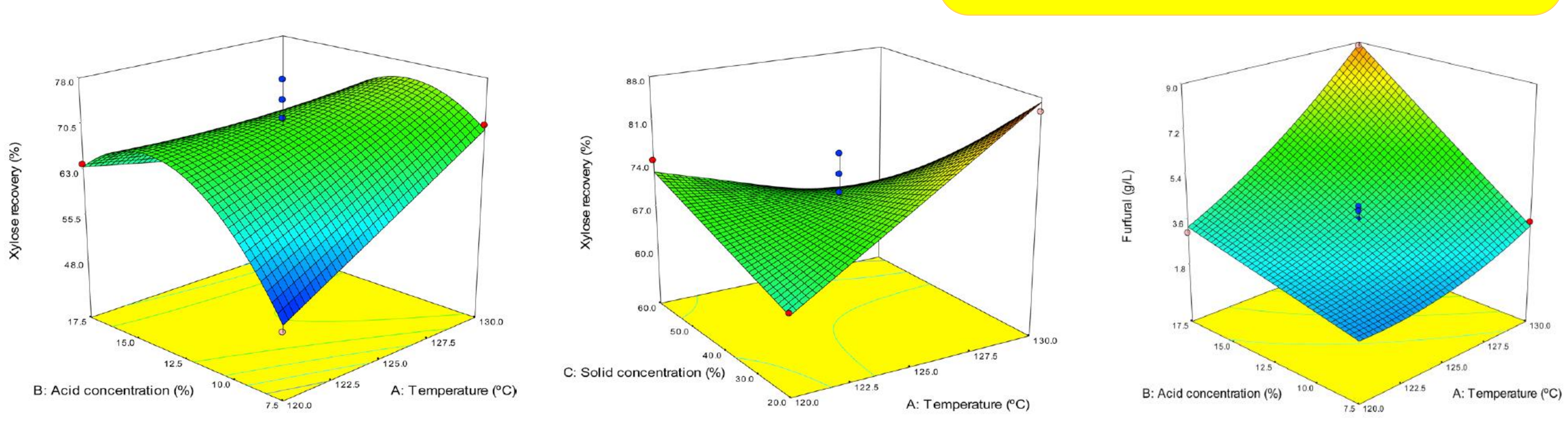
RESULTS AND DISCUSSION

ACID HYDROLYSIS

Box-Behnken design optimization
Criterion:
- Maximizing xylose concentration
- Maximizing xylose recovery
- Minimizing the furfural concentration

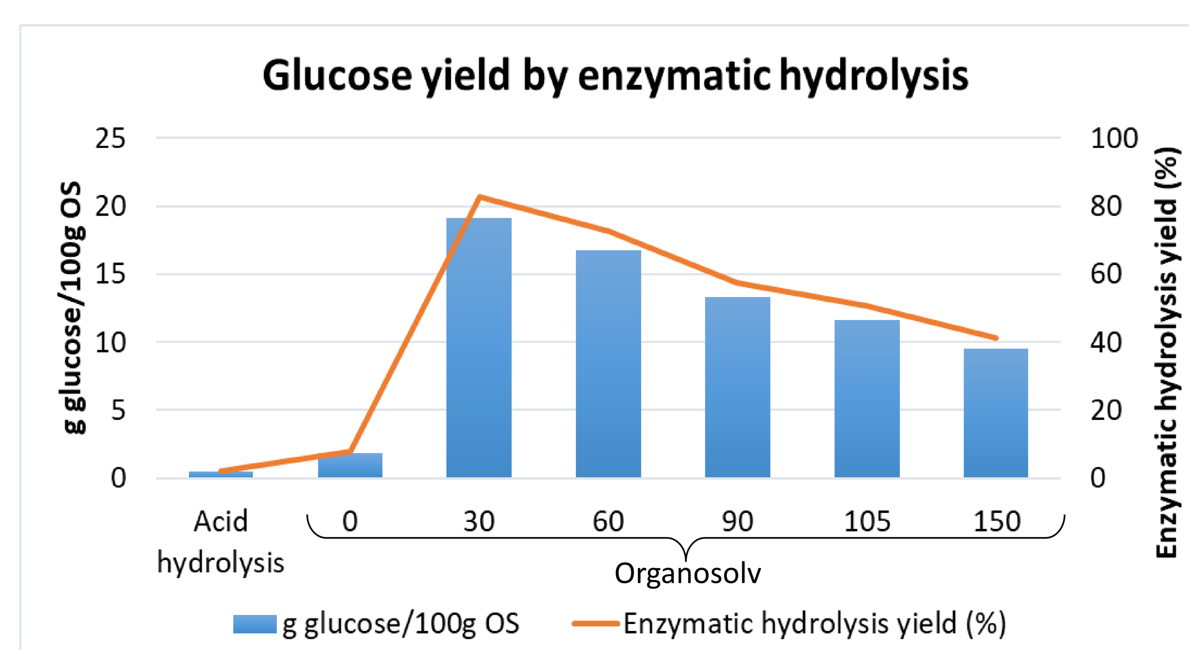
OPTIMAL CONDITIONS
- Temperature → 128 °C
- Acid concentration → 10.5%
- Solid concentration → 33%

Pretreatment liquor:
- **Xylose concentration: 62 g/L**
- **Xylose recovery: 71%**



Interaction
- At high levels of temperature and acid concentration xylose concentration decreased and furfural concentration increased.
- The pretreatment temperature had a positive influence at low solid loading on the xylose recovery but at high solid loading, its influence was negative.
- The temperature at low acid concentration had a positive influence on xylose recovery, while at the highest acid level this influence was negative.

ENZYMATIC HYDROLYSIS



- The enzymatic hydrolysis yields increase significantly with the implementation of the second organosolv stage.
- The enzymatic hydrolysis yield decreases over time due to the degradation of glucose by the increased severity of treatment that occurs in the organosolv stage.

Best condition for glucose solubilisation: 190 °C and 30 min

Enzymatic hydrolysis:
- **Glucose concentration: 25 g/L**
- **Glucose recovery: 83%**

CONCLUSIONS

- The use of a two-stage experimental methodology allows maximising the use of the sugars contained in the OS.
- The first acid stage was efficient for obtaining liquor with a high concentration of xylose, the main sugar in the hemicellulosic fraction of OS.
- A second organosolvent stage allowed an increase in the enzymatic hydrolysis yield, solubilising efficiently the cellulose contained in the solid.
- In the whole process, 41g of sugars per 100 g of OS were obtained, equivalent to 82% total sugars recovery.

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