Transformation of the polysaccharide fraction of corn stove into organic acids catalysed by Lewis acid catalyst in a subcritical water reaction medium

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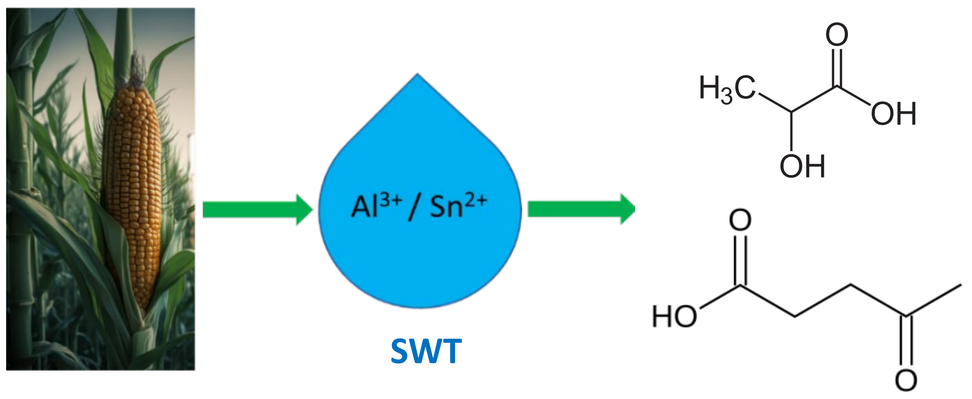
Background

General aim: Transit from a fossil based to a bio-based economy to produce high value chemicals.

Mean: Subcritical water treatment (SWT) of biomass (corn stover)

Specific work: Selective production of levulinic and lactic acids by using a mixture of Lewis acid catalysts



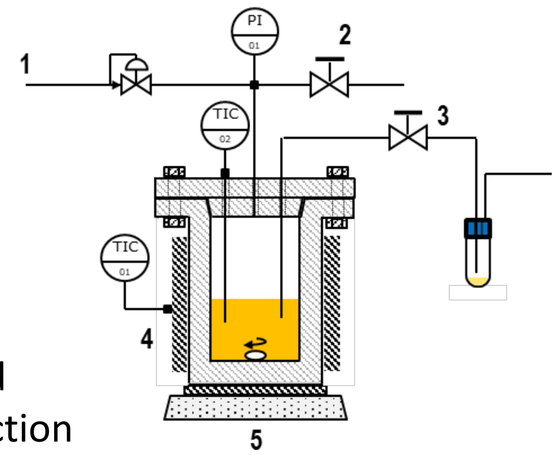
Equipment & Methodology

Discontinuous SWT operation

Catalysts: a combination of Al^{3+} and Sn^{2+} chloride salts

Catalyst concentration: 20 % of equiweight fraction of both salts considering the glucan fraction of corn stover.

Yield evaluation: Lactic acid yield was evaluated considering all the polysaccharide fraction of corn stover (cellulose + hemicellulose), and levulinic acid yield was determined considering only the cellulose fraction

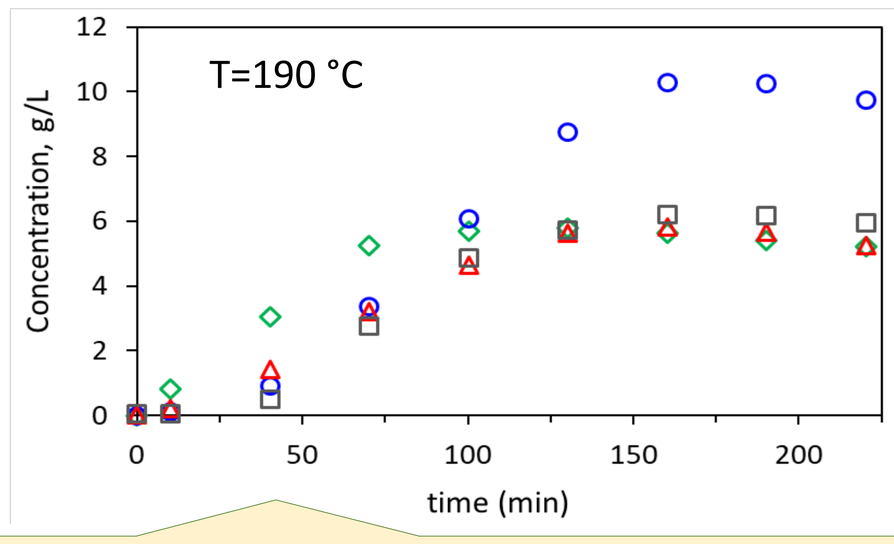


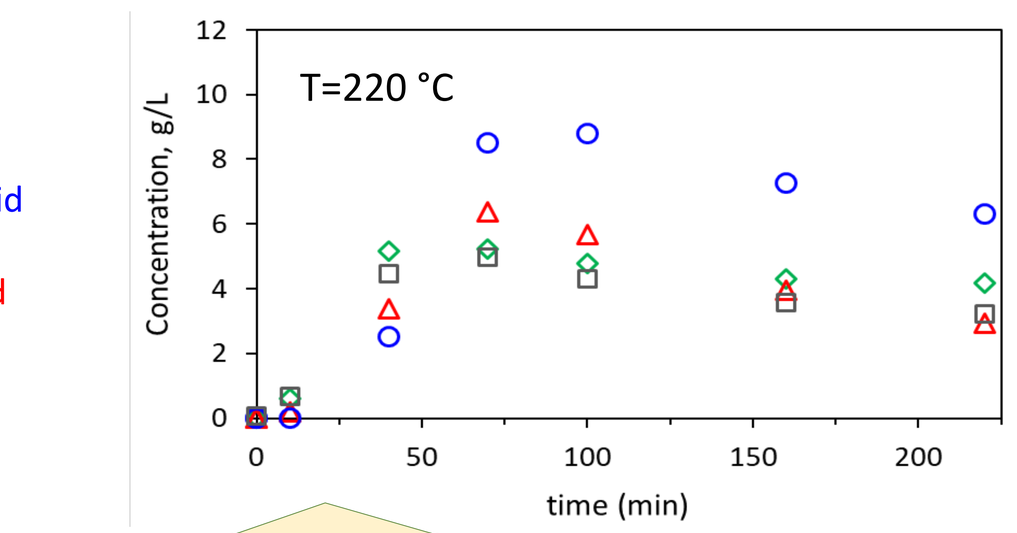
1. Pressurized agent line
2. Gas outlet, with purge valve
3. Sampling circuit, including sampling valve
4. Heating jacket (ceramic resistance 4000 W)
5. Magnetic stirring plate.

Temperature (T) and Pressure (P) Indicators (I) and Controllers (C)

Results

Organic acids concentration obtained from corn stover in subcritical water reaction medium catalysed by Al^{3+}/Sn^{2+}
Kinetic profile of the organic acids identified in the reactive system.





levulinic acid
lactic acid
formic acid
acetic acid

At 190 °C, similar final concentration was reached for lactic, formic and acetic acids with values in the range of 5.8 – 6.1 g/L, observing the highest concentration for levulinic acid, 10.3 g/L.

At 220 °C, a maximum was observed after 70 minutes of treatment after which, the concentration of the organic acids starts to decrease due to their degradation.

Cellulose → Glucose → Dihydroxyacetone ⇅ Glyceraldehyde → Pyruvaldehyde → Lactic acid

Cellulose → Glucose → HMF → Levulinic acid / Formic acid

Conclusion

Although the initial production rate of organic acids was faster at 220 °C, the highest yields were obtained at 190 °C. The maximum C-yield evaluated for lactic acid was 14.3%, considering the total polysaccharide fraction of corn stover (42.1 % glucans, 25.8 % xylanes and 4.6 % arabinans). The C-yield increases up to 56.8 % for levulinic acid. This difference is due its higher concentration, but mainly to its evaluation considering only the cellulose fraction of corn stover.

These results encourage the use of corn stover as a source of valuable chemicals such as organic acids. Further studies should be performed to a deeper analysis in terms of selectivity of the process.

Acknowledgements

This work was funded by the Agencia Estatal de Investigación (AEI), Ministerio de Ciencia e Innovación (MICINN) and Next Generation UE funds [grant numbers PID2022-136385OB-I00, TED2021-129311B-I00 and PDC2022-133443-I00] and by the Junta de Castilla y León (JCyL) and the European Regional Development Fund (ERDF) [grant number BU027P23].

The predoctoral contract of P. Barea was funded by JCyL and the European Social Fund (ESF) by ORDEN EDU/1868/2022, de 19 de diciembre. The contracts of H. Candela and A.E. Illera were funded by TED2021-129311BI00 and BU027P23, respectively.