Lactic production acid from biomass-derived sugars using acid or basic catalysts

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Subcritical water (subw) has been proposed as an alternative and promising solvent for fractionation of the biomass [1]. Sugars derived from biomass, hexoses and pentoses, can be used as starting materials for further conversion to a range of value-added products. Among these compounds, second-generation lactic acid (2G-LA) is a promising sugars-derived building blocks. Different catalytic hydrothermal process has been considering so far to selectively produce 2G-LA. These catalytic systems are divided into basic and acids which have different catalytic reaction pathway.

The present study evaluates the kinetics of lactic acid formation from xylose (pentose) and glucose (hexose), as reference sugars derived from biomass. The study was carried out in the presence of the homogeneous basic catalyst $Ca(OH)_2$ and the combination of homogeneous acid catalysts $AlCl_3$ + $SnCl_2$. Kinetics studies were carried out in a discontinuous steel reactor (500 mL) with a ceramic heating jacket provided with a PID system to control and register the T inside the reactor. In all the experiments, the operating temperature was set at 190 °C and the pressure at 55 bar. The composition of the liquid aliquots was analyzed by HPLC.

Figure 1a shows the evolution of lactic acid yield over time for the different combinations of sugars and catalysts. In general, the same trend is obtained, in the first few minutes the yield increases until it reaches a maximum which is maintained over time. It is shown that both, the basic catalyst ($Ca(OH)_2$) and the combination of acid catalysts ($AlCl_3$ + $SnCl_2$) are active in the conversion of hexoses and pentoses into lactic acid. If the catalysts are compared with each other, it is observed that the presence of acid catalysts is more effective for glucose conversion; however, for xylose conversion alkaline catalysts present a higher yield. This fact, together with the different product distributions observed (Figure 1b), confirms that depending on the type of catalyst and the starting sugar, the route by which lactic acid is formed is different.

The lactic acid produced presents stability over time. In the 100 minutes studied, no degradation is observed over time. In addition, the experiment with glucose and $Ca(OH)_2$ is extended to 300 minutes and there is still no degradation of the lactic acid produced. Finally, based on the study carried out, it is concluded that lactic acid can be produced from sugars derived from biomass, both with basic and acid catalysts, and it is also concluded that it is a stable system, since no degradation is observed of lactic acid produced over time.

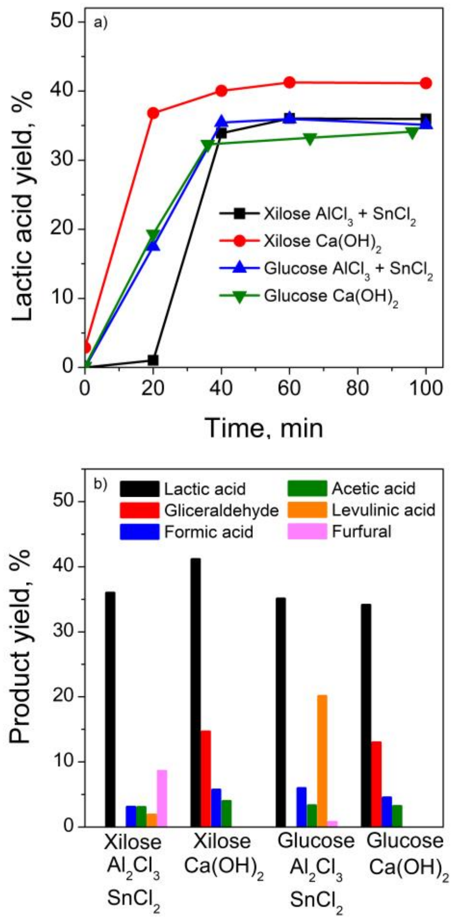

Figure 1. (a) Evolution of the lactic acid yield with the time. (b) Product distribution for the different combination of sugar and catalyst. *Reaction conditions: t=100 min, 200mL, sugar 0.05M, catalyst 0.1M, 190 °C, 55 bar.*

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References:

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