Kinetic characterization of bioethanol production from xylose and glucose by *Spathaspora passalidarum* in the presence of furfural

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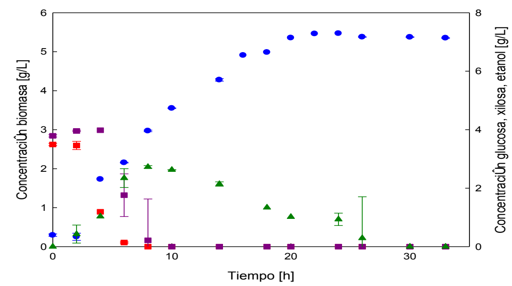
Introduction. Lignocellulosic biomass is an abundant raw material for bioethanol production. After pretreatment and hydrolisys the main sugars present are pentoses and hexoses, and also several compounds that have a negative effect in the fermentation stage. To get high bioethanol yield from lignocellulosic materials, it is necesary a microorganism able to ferment both type of sugars and able to overcome the inhibitory effect of such compounds formed during previous stages. The results obtained in the kinetic characterization of the fermentation of xylose and glucose by *Spathaspora passalidarum* in the presence of furfural are presented in this work.

Methods. Microorganism *S. passalidarum* NRRL Y-27907. Culture medium: 5 $g{\cdot}L^{-1}$ yeast extract, 0,7 $g{\cdot}L^{-1}$ KH_2PO_4, 1,7 $g{\cdot}L^{-1}$ NH_4Cl and 0,3 $g{\cdot}L^{-1}$ $MgSO_4{\cdot}7H_2O$. Carbon source: 8 $g{\cdot}L^{-1}$ glucose/xylose/mixture. Aerobic and anaerobic growths were performed using 50 mL and 200 mL of working volume in 250 mL flasks. Strict anaerobic condition bottles were bubbled with N_2 and then sealed. Furfural concentration: 0,8; 1,6 and 2,4 $g{\cdot}L^{-1}$. The flasks were incubated at 32 °C and 120 rpm. Cell growth was measured by optical density at 620 nm**.** Glucose, xylose and ethanol, were analyzed by HPLC using HP 1100 RID detector, equipped with a Biorad HPX-87-H column. Furfural was analyzed by HPLC using a UV detector.

Results. Results under aerobic condition showed the ability of the yeast to co-fermented simultaneously glucose and xylose to ethanol, obtaining bioethanol concentration of 2,73 $g{\cdot}L^{-1}$, and bioethanol yield of 0,37 $g{\cdot}g^{-1}$,and a volumetric productivity of 0,34 $g{\cdot}L^{-1}{\cdot}h^{-1}$. Under anaerobic condition, xylose was consumed after glucose, achieving an ethanol concentration of 3,46 $g{\cdot}L^{-1}$, while ethanol yield and volumetric productivity were 0,49 $g{\cdot}g^{-1}$ and 0,28 $g{\cdot}L^{-1}{\cdot}h^{-1}$, respectively. This suggests that *S. passalidarum* use different xylose transport systems under anaerobic and aerobic conditions. Hou *et al.*, 2012 reported a lower cell yield with *S. passalidarum* growing on xylose respect to the yield on glucose and suggested that *S. passalidarum* might use low-affinity, low-capacity facilitated diffusion for growth under O_2 limitation, while during aerobic growth use high-capacity, high-affinity system.
Additionally, under strict anaerobic conditions, consumption of glucose was 78% higher than xylose, reaching an ethanol concentration of 0,97 $g{\cdot}L^{-1}$.

A



B

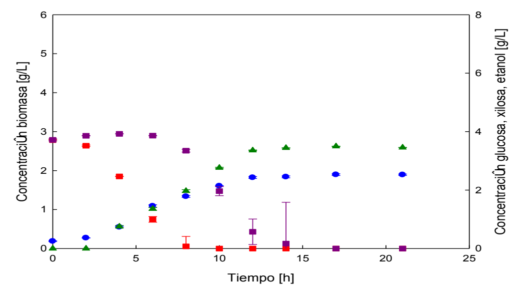


Fig.1 Co-utilization of glucose and xylose under aerobic (A) and anaerobic (B) conditions by *S. passalidarum.* Symbols: red squares, glucose; violet squares, xylose, blue circles, biomass; green triangles, ethanol.

The effect of furfural in bioethanol productivity was measured in anaerobic condition, due to the best bioethanol concentration obtained. In this condition the growth rate is slightly slower than the control cultura, grow, it did not present lag phase, however it showed the same yield of ethanol, but the productivity of ethanol decreased in around 73% and the biomass yield in 59% respect to the control condition.

Conclusions. *S. passalidarum* present a high potential to be used in bioethanol production from lignocellulosic materials, due to its capacity to co-ferment glucose and xylose and be it is able to grow in the presence of furfural, but the strain must be adapted to its presence in order to get a productivity that makes feasible its use in an industrial process.

References.

Hou X.(2012). *Appl. Microbiol. Biotechnol.* 94:205-214