Efficient bioconversion of lignocellulose-derived pentose sugars into ethanol and butanol under catalyzed hydrothermal pretreatment, detoxification treatment and extractive fermentation from sugarcane bagasse

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Introduction

❑In a world that is increasingly turning its attention toward the absolute necessity of sustainability, it is necessary a constant search for better, smarter, more efficient and economical ways to expand the energy supplies.

❑There is a need for the recognition of new energy sources and new technologies to expand the production of biofuels. A major issue is that focused in biofuels used for transport such as ethanol and butanol.

❑Lignocellulosic biomass need to be pretreated to increase the susceptibility of the hemicellulose to hydrolysis. However, the pretreatment leads to the formation of undesirable products, which have a serious inhibitory effect in subsequent fermentation steps.

❑Thus, in order to develop a more cost-effective process it is necessary a prior detoxification of the hydrolysates to improve fermentability, and to study new alternatives for the fermentation process.

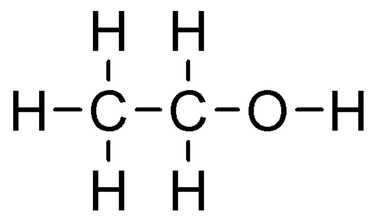
❑Sugarcane bagasse is a renewable, abundant and economical alternative for the sustainable production of Second-Generation Biofuels (2G).

Goals

❑The challenge in this project comprises **to perform an efficient process to bioconversion of lignocellulose-derived pentose** (from sugarcane bagasse) into ethanol and butanol with reduced pentose-fermenting microorganisms input.

❑The research project focuses on **the reducing of inhibitors formed during acidic hydrothermal pretreatment of lignocellulosic feedstock**, and how conditioning the hydrolysates can be used to alleviate inhibition problems during **the promising extractive fermentation process**.

Ethanol



❑ It is currently considered the most efficient and important current biofuel ready to be used.

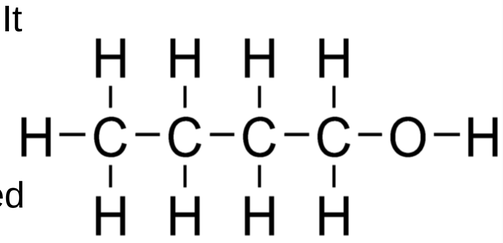
❑ Several years of experience in the market, especially in Brazil and USA.

Butanol

❑ Superior energy content and similarity to gasoline, which would require less changes in engines. It can be blended into gasoline at higher concentrations.

❑ Truly drop-in biofuel—can be used in existing vehicles and infrastructure.

❑ It does not separate in water.



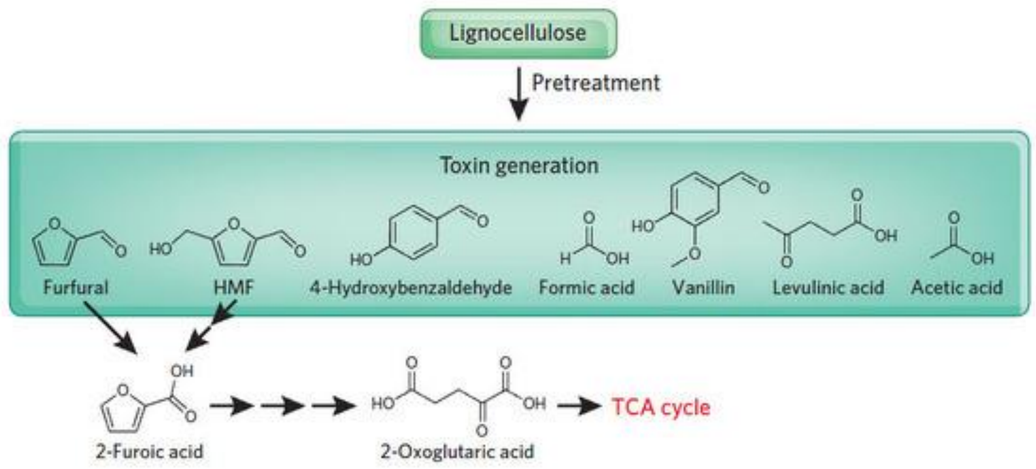


Figure 2. Toxic inhibitors generated during lignocellulose pretreatment (Dong and Bao, 2010).

Materials and methods

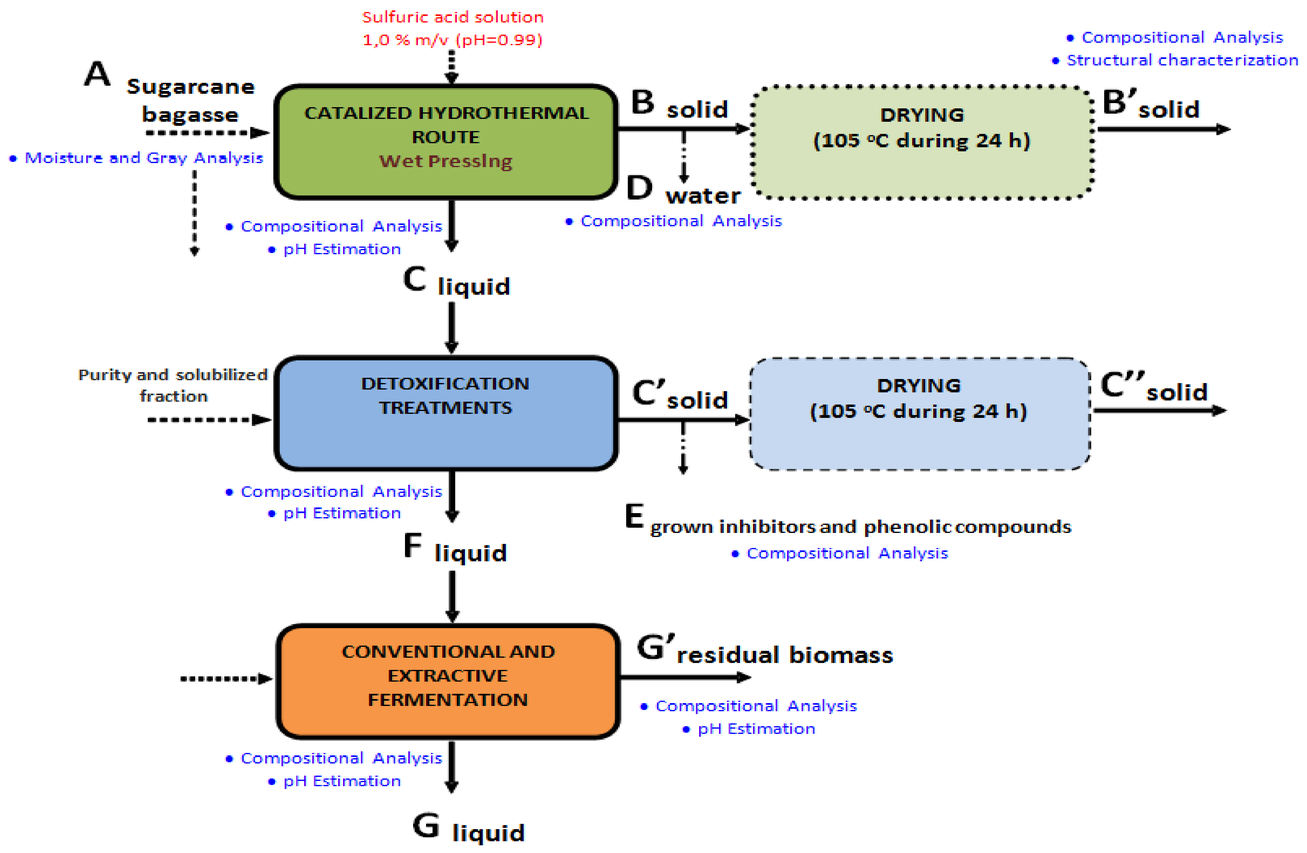


Figure 1. Process flow diagram. B_{solid}: Pretreated biomass; C_{liquid}: Acid hydrolysate samples; $D_{wash\ water}$: Water wash used to wash pretreated biomass to reach neutral pH after H_2SO_4-catalyzed hydrothermal route; F_{liquid}: Pentose sugar solution free from growth inhibitors; G_{liquid}: Product from conventional and extractive fermentations.

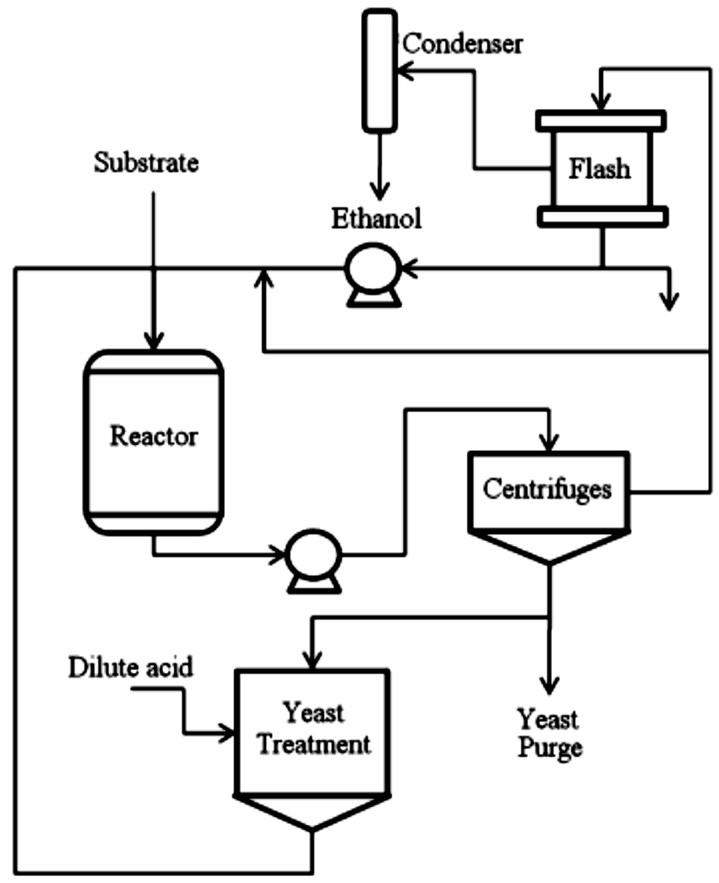


Figure 3. Simplified diagram of the extractive fermentation process coupled with a vacuum flash chamber (Dias et al., 2012).

References

❑ Dias MOS, Junqueira TL, Jesus CDF, Rossell CEV, Maciel Filho R, Bonomi A, 2012. Improving bioethanol production–comparison between extractive and low temperature fermentation. Appl. Energy; 98:548–555.

❑ Dong H, Bao J, 2010. Biofuel via biodetoxification. Nature chemical biology; 6:316-318. Available from: www.nature.com/naturechemicalbiology.