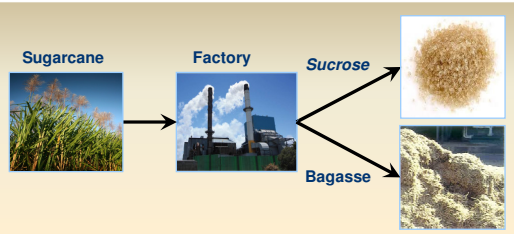

Production of Organic acids and Furanics from Sugarcane Bagasse

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INTRODUCTION

Sugarcane waste (i.e. bagasse) is an abundant and relatively low cost carbohydrate resource. Platform chemicals such as levulinic acid and furanics can be produced through acid-catalyzed dehydration and hydrolysis of carbohydrates.

Commercial production of levulinic acid and furfural suffers from the use of corrosive mineral acid catalysts such as sulfuric acid (H_2SO_4) which increase equipment and operating costs and can lead to waste disposal issues associated with non-recovery of the catalyst [1,2]. Research is currently being undertaken with green acids and co-solvents such as glycols in an effort to improve the overall process of producing the compounds.

EXPERIMENTAL

- Feed - Glucose/xylose mixtures (equivalent in proportion to different types of lignocellulose) and sugarcane bagasse
- Strong sulfonic acid catalysts (pK_a<-1.8) of low corrosivity
  - Methanesulfonic (MSA), ethanesulfonic (ESA) and *p*-toluenesulfonic acid (TSA)
- Ethylene glycol (EG) co-solvent (high boiling point lignin solvent)
- Operating conditions → 160-200°C (heat up time <2 min); 8-75 min; 0.1-0.8 M acid; 0-90% co-solvent; 1-7 wt% feed

SUGARS – CATALYSTS

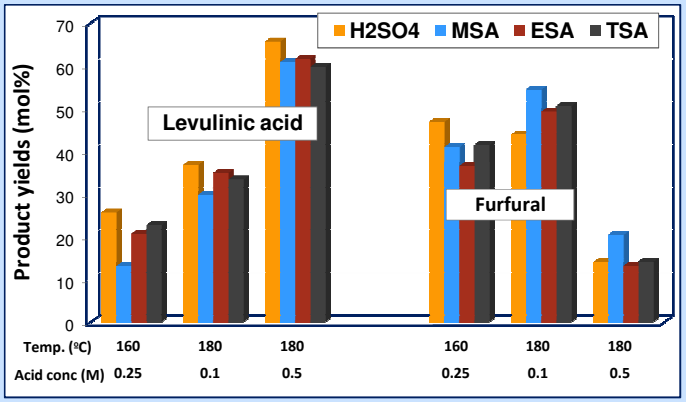


Fig. 1 – Product yields from acid-catalyzed reaction (30 min) of sugars

- Selectivity among catalysts not significantly different (Fig. 1)
- Activity linked to acid strength

BAGASSE – EG CO-SOLVENT

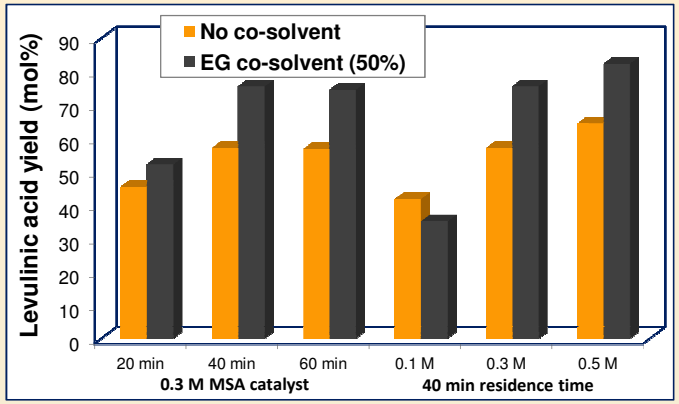


Fig. 2 – Levulinic acid yields from acid-catalyzed (MSA) reaction of bagasse at 180°C

- Harsh conditions ↑ yield of levulinic acid (Fig. 1 & 2)
- Total levulinates (lev acid + mono/di -esters) increased with co-solvent concentration and harsher reaction conditions
  - Carbon yield increased by up to ~20%

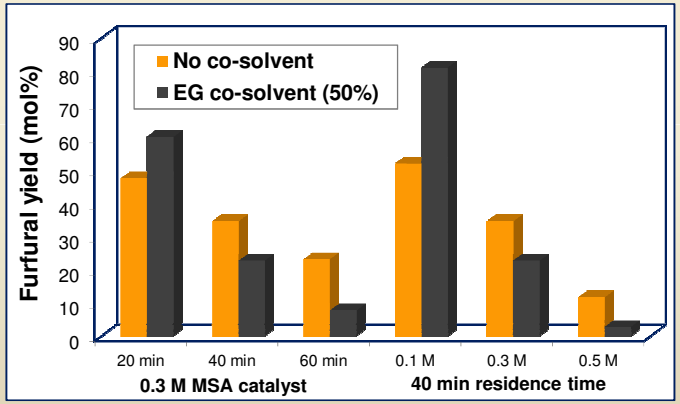
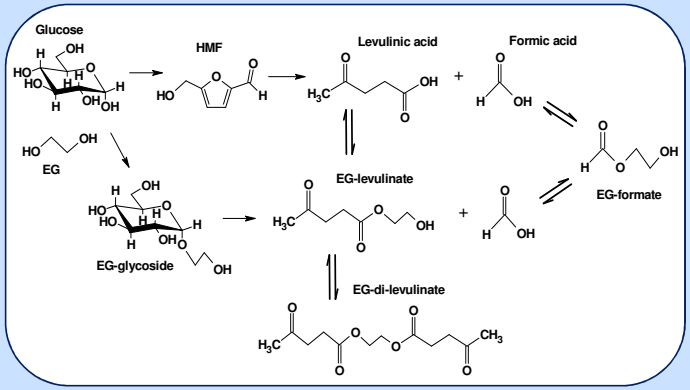


Fig. 3 – Furfural yields from acid-catalyzed (MSA) reaction of bagasse at 180°C

- Mild conditions (& less reactants) ↑ yield of furfural (Fig. 1 & 3)
  - EG improved yields of furfural produced under mild conditions
- Formic acid to levulinic acid ratio ~1.2 for bagasse (no co-solvent)
- Acetic acid (yields of 8-10 wt% for all conditions for bagasse

- Introduces additional reaction pathways (Scheme 1)
  - Formate, acetate and levulinate acids and EG mono/di- esters



Scheme 1 – Possible reaction pathways with EG

- Ratio of esters to acid dependent on EG concentration
  - Levulinate esters 24-55% of total levulinates
  - Acetate esters 10-30% of total acetates
  - Formate esters 2-8% of total formates
- EG reduced amount of solid residue

CONCLUSIONS

- **Process conditions selected to optimise product yields**
- First stage → furfural and acetic acid production
  - Rapid heating, short time, low temperature, low acid conc.
  - Flash recovery to remove products and concentrate acid
- Second stage → formate and levulinate production
  - Higher temperature and longer reaction time
  - Recovery steps for products, solvent and catalyst

ACKNOWLEDGEMENTS

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REFERENCES

[1] Fitzpatrick, S.W., 1997, US Patent 5,608,105.
[2] Rackemann, D.W. and Doherty, W.O.S., 2011, *Biofuels, Bioproducts & Biorefining, 5, 198-214.*