Match Maker/ Sustainable Ingredients/ 3 Feb 2023

Bio-manufacturing of XOS/ Xylobiose for prebiotic application

Lead Inventor: Dr Naseem Gaur

Organization: ICGEB

TechEx.in Case Manager: Pradnya Aradhye (pradnya@venturecenter.co.in)

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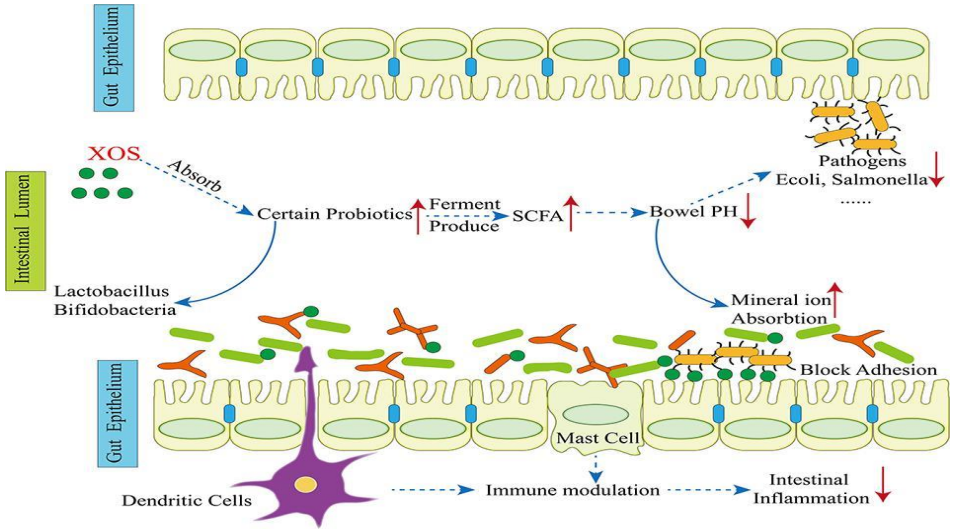
Prebiotics: Overview and Types

- Prebiotics are sugar polymers such XOS, FOS etc. which promote growth of beneficial bacteria in the gut
- XOS has high potential w.r.t other prebiotic in terms of $/dose
- The global prebiotics market size was valued at USD 6 billion in 2021 and is expected to grow at a compound annual growth rate (CAGR) of 14.9% from 2022 to 2030. Types of prebiotics available in the market: FOS, XOS, GOS, Inulin etc.

Mechanism of action



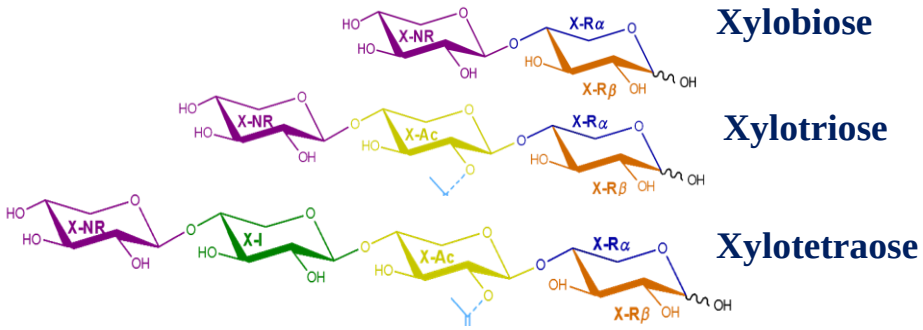
https://doi.org/10.3389/fnut.2021.731930

Health Benefits of Prebiotics

- Reduce infectious and antibiotic-associated diarrhea
- Reduce the inflammation
- Exert protective effects to prevent colon cancer
- Enhance the bioavailability and uptake of minerals, including calcium, magnesium, and possibly iron
- Lower some risk factors for cardiovascular disease
- Promote satiety and weight loss and prevent obesity

- We developed a technology to produce XOS (>96% xylobiose) biologically from hemicellulose at an affordable MSP

About Xylo-oligosaccharide (XOS)



And other higher oligosaccharides

Current status:

Biomass → (Chemical/Autohydrolysis method) → XOS

- Low control over DP
- Uses harsh chemicals and extreme conditions
- Extensive downstream processing- multistep purification
- Risk of chemical contaminations

Varieties available in the market:

- Variety with < 30% xylobiose:
- Variety with > 90% xylobiose:

The Opportunity: Xylobiose

- Global xylobiose market is predicted to be valued at US$ 700 million in 2022 and is projected to reach US$ 960 million by 2028, expanding at a CAGR of 5.2 % from 2022-2028 (The Market Report)

- Current selling price of XOS:

  Variety with < 30% xylobiose: 25-100 $/kg (Source: Alibaba): in use as nutritional supplement

  Variety with > 90% xylobiose: ~ 1000 US$/g (Source: Alibaba): Not in use as nutritional supplement due to high cost

Factors driving the demand:

1) Natural supplement to boost the immunity and health benefits
2) Improved gastrointestinal health and gut microbiota

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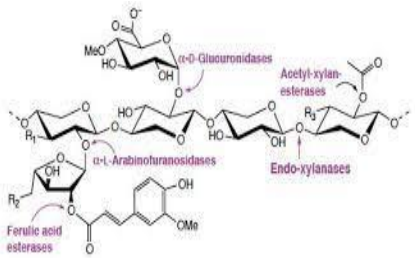
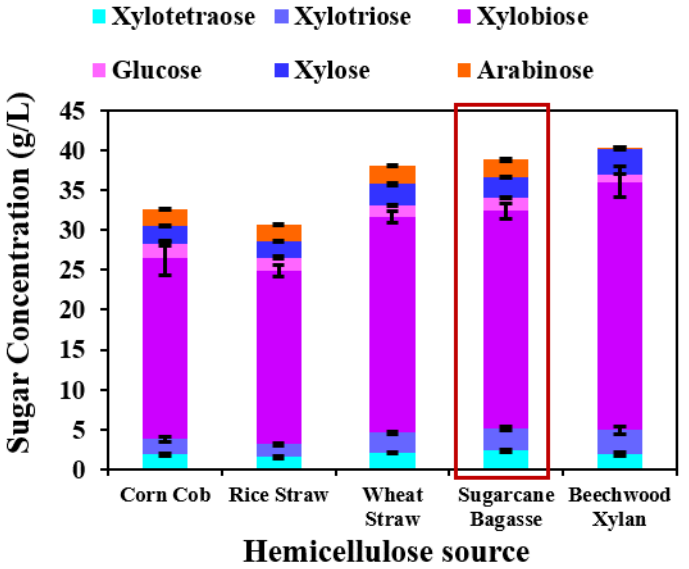
About the technology

Hemicellulose



Enzymatic hydrolysis
by novel non-GMO enzyme cocktail



Major component obtained is Xylobiose

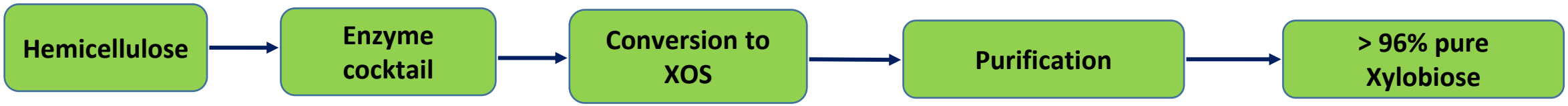
Process features:

- Enzymatic process using Hemicellulose
- Environmental friendly and sustainable
- Easy purification process of XOS
- Uniform and consistent product quality
- Yield ~30 g/L

Product features and current status:

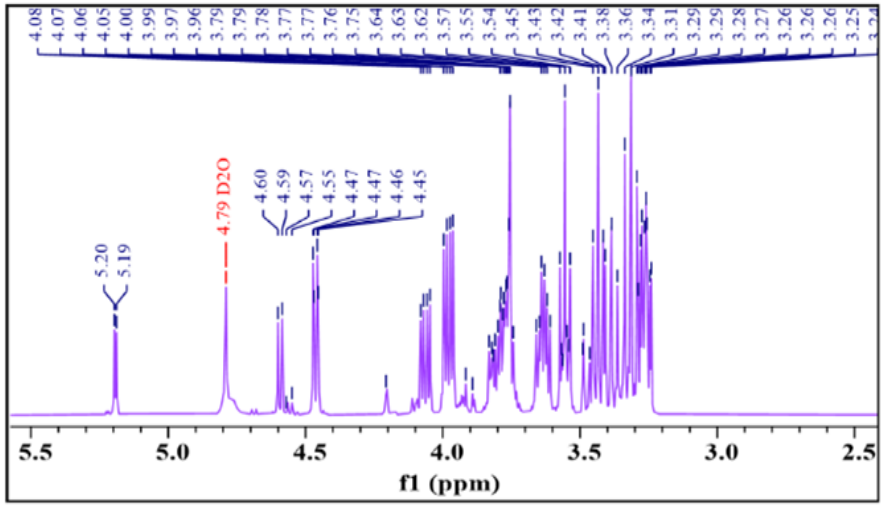
- XOS with > 96% Xylobiose
- By products – minimal
- Estimated MSP: ~8 USD/kg based on TEA analysis

About the technology: Work Flow

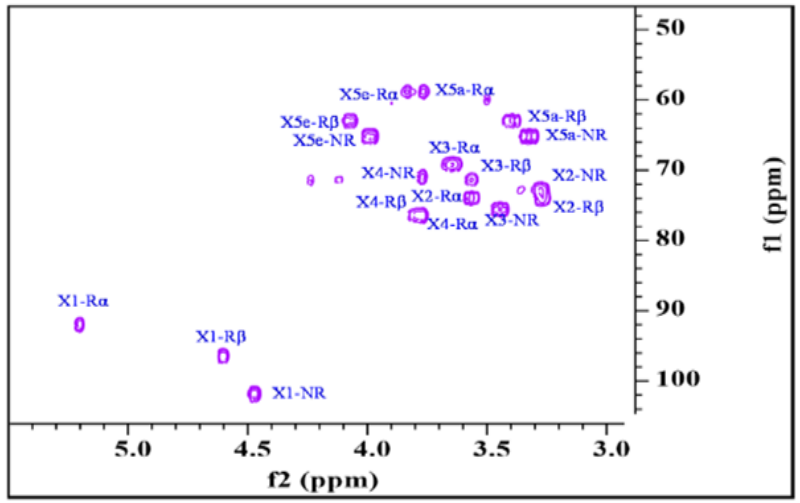


✔ **NMR studies of the purified product confirmed the purity and no trace of chemical contamination was detected**

1H-NMR



2D-HSQC



Current status

Technology status:

- Demonstrated at lab scale
- Patent filed :
  NOVEL PROCESS FOR XYLOBIOSE AND ETHANOL CO-PRODUCTION

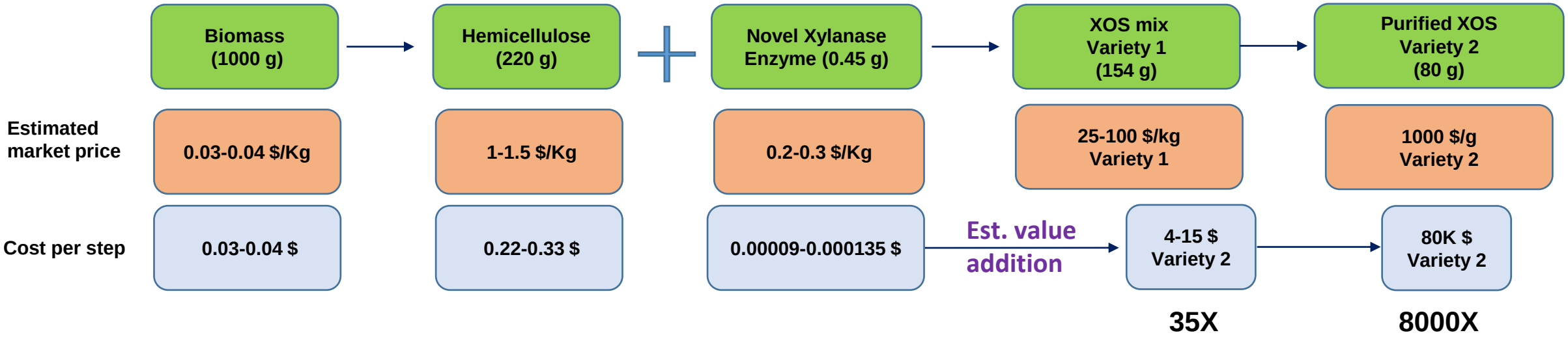
Patents:

- Priority document: **TEMP/E- 1/88472/2022-DEL**
- Coverage: IN
- Status: Filed

Publications:

- Wani, S. A., Sharma, J., Gaur, N. A. (In progress). Process development and sustainability assessment of an integrated biorefinery for xylobiose and ethanol production.
- Wani S. A. (2022) Thesis Title: Microbial xylo-oligosaccharide production from lignocellulosic biomass.

Technology demonstration done:



Who should be interested and why?

Who?	Why?
Manufacturers of XOS	• No contaminants; bio-synthesized • Low-cost process • Source of competitive edge • Pure Xylobiose
Sugar industries	• New value-added product and expansion into new markets
Manufacturers of Prebiotics	• New product in the portfolio and expansion into new markets

Next Steps

- The team has developed the background science and demonstrated lab-scale processes as a proof-of-concept. The team understands how the process can be modified to get desired products.

- The next phase will be to work closely with industry partners to
    - Define techno-commercial specifications for the product and process of interest
    - Optimize process to meet industry requirements

- Scale-up, further optimization to meet end-customer needs, testing, and certifications.

Seeking:

- Industrial partners interested in technology licensing
- Industrial partners interested in sponsoring further technology advancement and scale-up
- Industrial partners interested in raising 3rd party funds for a collaborative project.
- Industry interested in tapping scientist capabilities as an expert/ consultant.

Team & organization

Lead Scientist: Dr. Naseem Gaur

Group Leader, Yeast Biofuel Group, ICGEB, Delhi
Expertise: Microbial Engineering, Synthetic Biology, Biofuels, Bioprocessing
Awards: Ramanujan Fellow, Best Science Award-NIH, Harvard Alumni, NIH Alumni
Journal associated: Journal of Fungi, Bioresource technology, Renewable energy, Biotechnology advances, Biotechnology for biofuels

- ICGEB established under UNIDO in 1983, the ICGEB is a unique, autonomous, Intergovernmental Organization, with biotech labs in Italy, India, and South Africa.
- Key assets and strengths of Dr. Gaurs Lab:
  - **4** Indian patents filed **More than 50** publications in biofuels, yeast metabolic engineering, and yeast strain development.
  - Team strength: 12
  - Well-equipped labs and analytical facilities
    - 20 L fermenter facility for validation
    - Mass Spectrometer
    - Multi-vessel fermentation system
    - HPLC and Gas chromatography
  - Industry Project /Tech transfer
    - Project undertaken with various International companies

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Tech Transfer Hub

ICGEB International Centre for Genetic Engineering and Biotechnology
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innovate in India for inclusiveness (i3)

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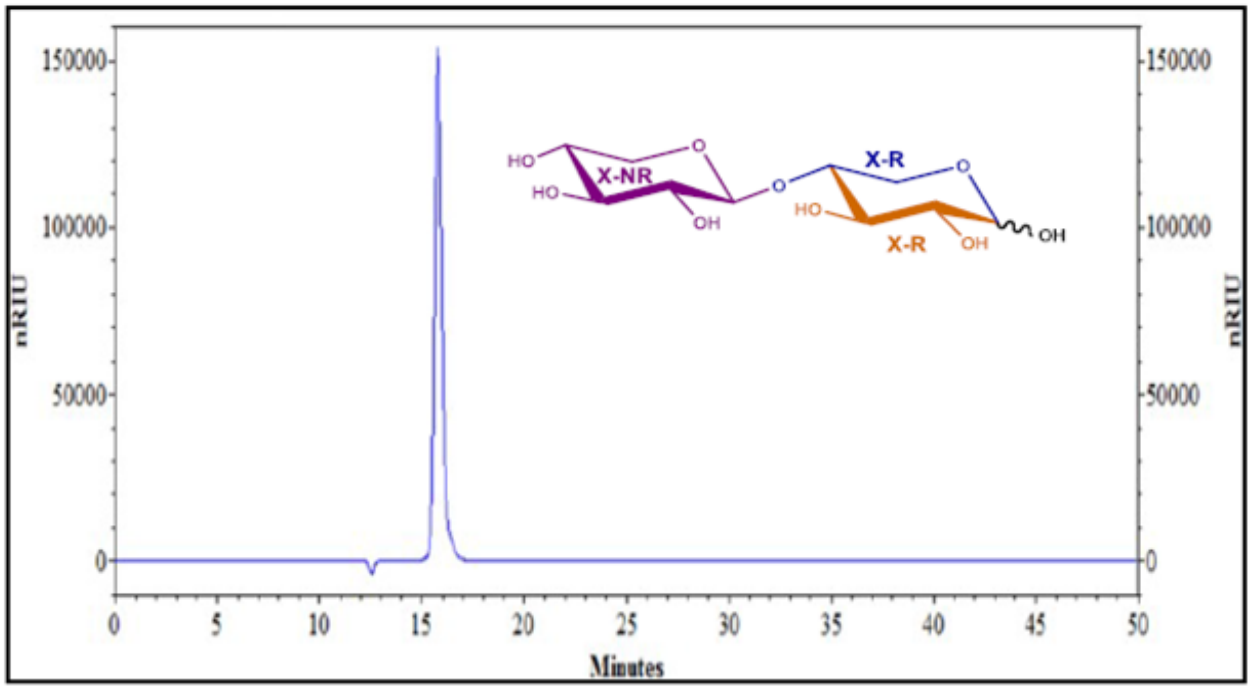
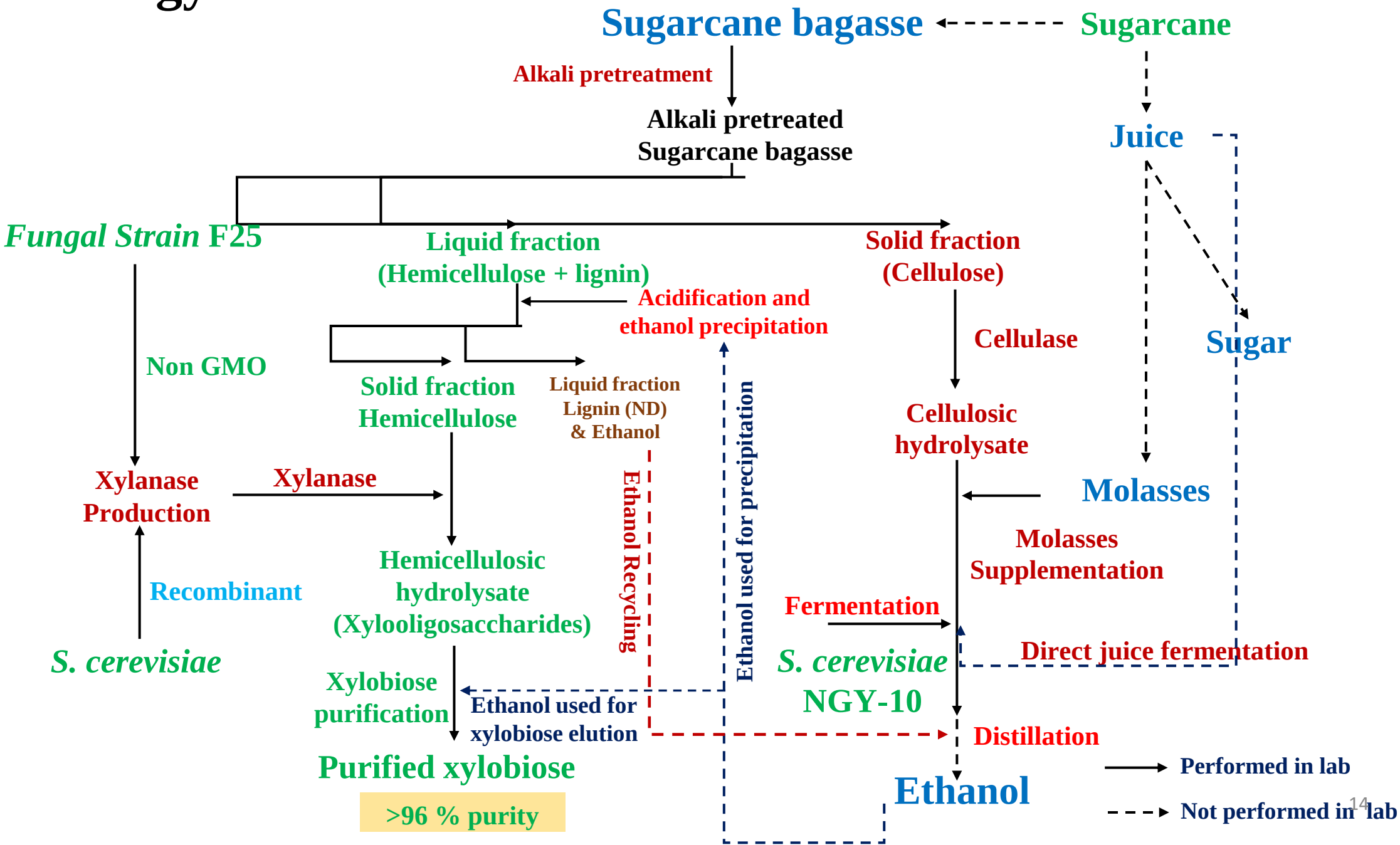
Extra slides

HPLC profile of purified XOS



Technology workflow



Technology Efficiency

The Process involve multiple steps including

- Pretreatment
- Enzymatic hydrolysis
- Fermentation
- Purification