Hamburg University of Technology, Institute of Thermal Separation Processes

Liquid Hot Water Hydrolysis for the Extraction of β-Glucans from Industrial Residues

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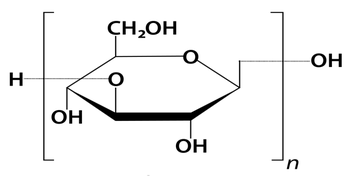
Motivation & Project Objectives

- **The Goal:** The transition to a circular bioeconomy requires transforming low-value industrial side-streams—such as cereal residues (brewer's spent grain, wheat bran) and microbial biomass (spent yeast cell walls) into high value functional ingredients.
- **The Value:** β-Glucans (BG) possess exceptional, structure-dependent techno-functional (gelling, thickening) and bioactive (immunomodulatory, cholesterol-lowering) properties.
- **The Bottleneck:** Traditional extraction relies on unsustainable, chemical-heavy batch processes.



- **Objective 1:** Maximize BG yield and purity while preserving high-molecular weight structures.
- **Objective 2:** Suppress hydrothermal degradation pathways.

Severity optimization

Achieving a highly reproducible and scalable continuous operation requires precise control over the biomass heat history, which is mathematically standardized using the Severity Factor(R_0):

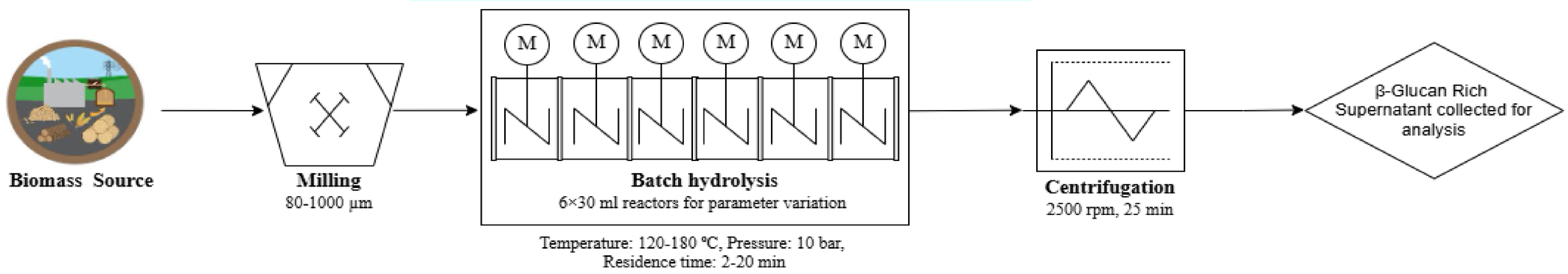
$$\log R_0 = \log\left(t \cdot \exp\left(\frac{T-100}{14.75}\right)\right)$$

Where,

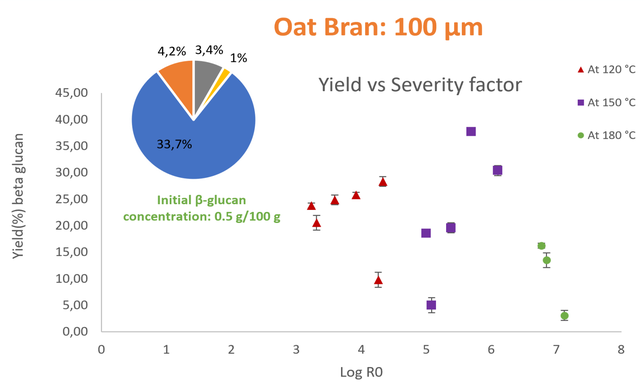
- **t** is the residence time (minutes).
- **T** is the reaction temperature (°C).
- **14.75** is an empirical constant related to the apparent activation energy of hydrothermal reactions

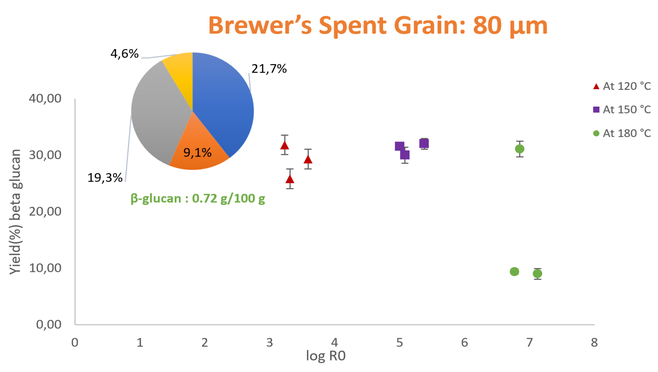
Instead of treating severity as a standalone theoretical metric, to evaluate its direct impact on real extraction efficiency. Solubilized β-glucan content in the liquid hydrolysate is precisely quantified using the Megazyme® Mixed Linkage Assay Kit.

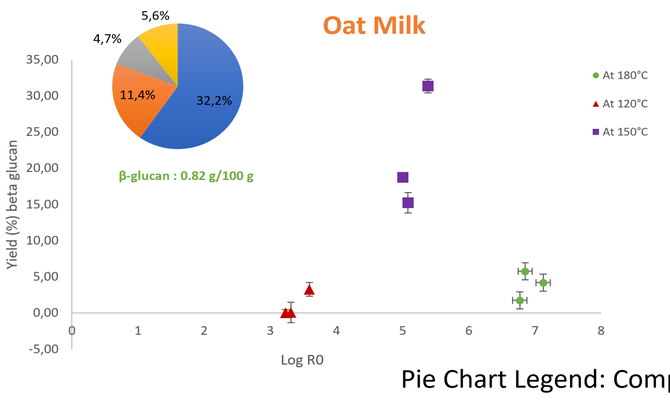
Standardized Technical Flowchart

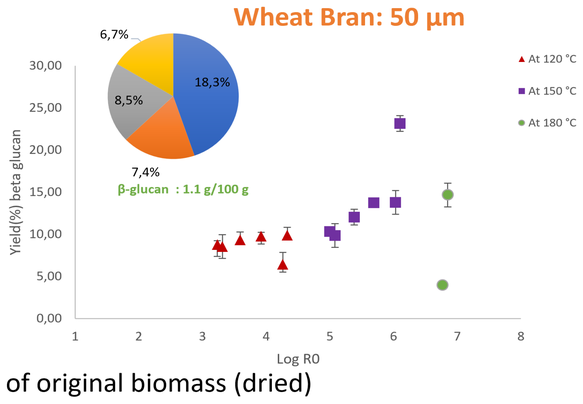


Results and Discussion



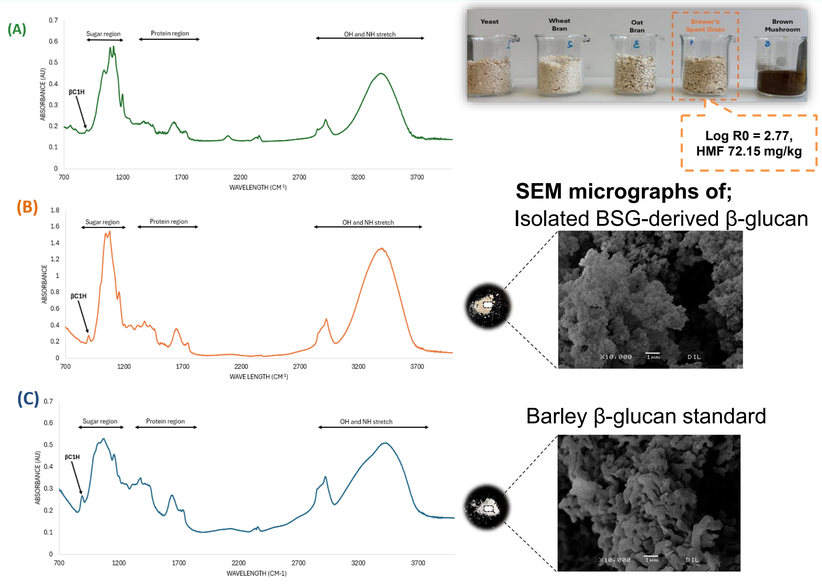






Pie Chart Legend: Composition of original biomass (dried)

● Protein content (%) ● Ash content (%) ● Fat Content (%) ● Fiber Content (%)



FTIR spectra of **(A)** BSG hydrolysate, **(B)** isolated BSG β-glucan, and **(C)** Barley β-glucan standard (Megazyme). **βC1H** – Beta glucan specific signal.

Sample matrix	Process condition	Severity factor	L*	a*	b*
BSG	120 °C, 20 min	3,07	79.81	-0.16	21.16
BSG	155 °C, 2 min	5,08	58.7	9.46	24.19
BSG	155 °C, 20 min	5,72	65.56	6.39	25.58

CIELAB Colour dimensions of the freeze-dried hydrolysates

Outlook and Conclusions

- ❑ **Resolving technical bottlenecks: residence time, water recovery, heat integration while ensuring optimized process is cost effective, compliant and market ready. Establishing a tool for predicting a link between composition, optimized particle size, optimized severity factor and LHW efficiency.**
- ❑ **Inline fractionation: Multi stage set ups that adjust temperatures sequentially to fractionate different molecular weights of β-glucan in a single continuous process.**
- ❑ **Implementing the optimized hydrolysis set up as side streams in various industries producing large amount of agricultural waste products rich in β- glucans.**
- ❑ **Shifting from batch reactors to continuous flow setups to increase industrial feasibility.**

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