SECOND-GENERATION BIOETHANOL PRODUCTION: STRATEGIES FOR SIDESTREAMS VALORISATION IN A SUSTAINABLE CIRCULAR ECONOMY

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Introduction

- Great attention has been paid to liquid biofuels produced from lignocellulosic biomass.
- The production of liquid biofuels still has environmental, economic and energetic limitations:

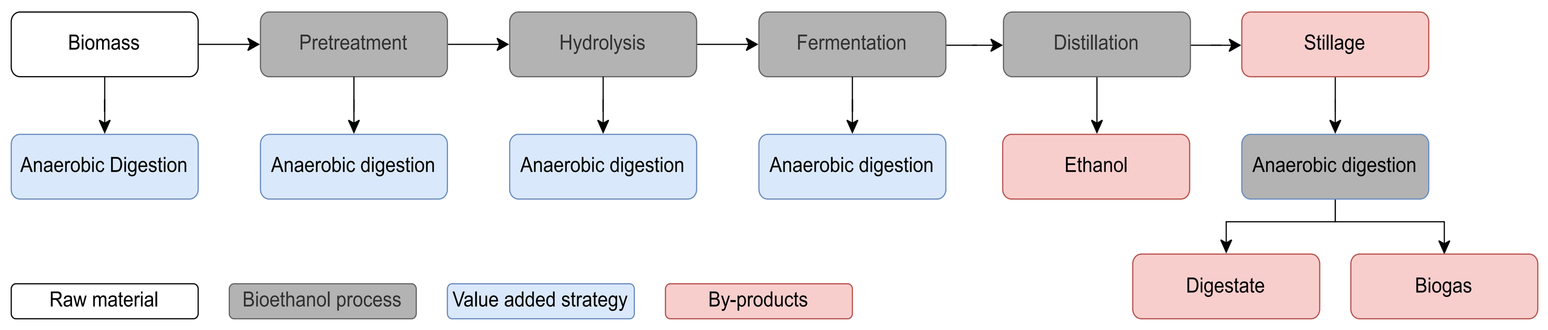
  a) Large volume of sidestreams are produced

  c) High costs of pretreatment and enzymatic hydrolysis

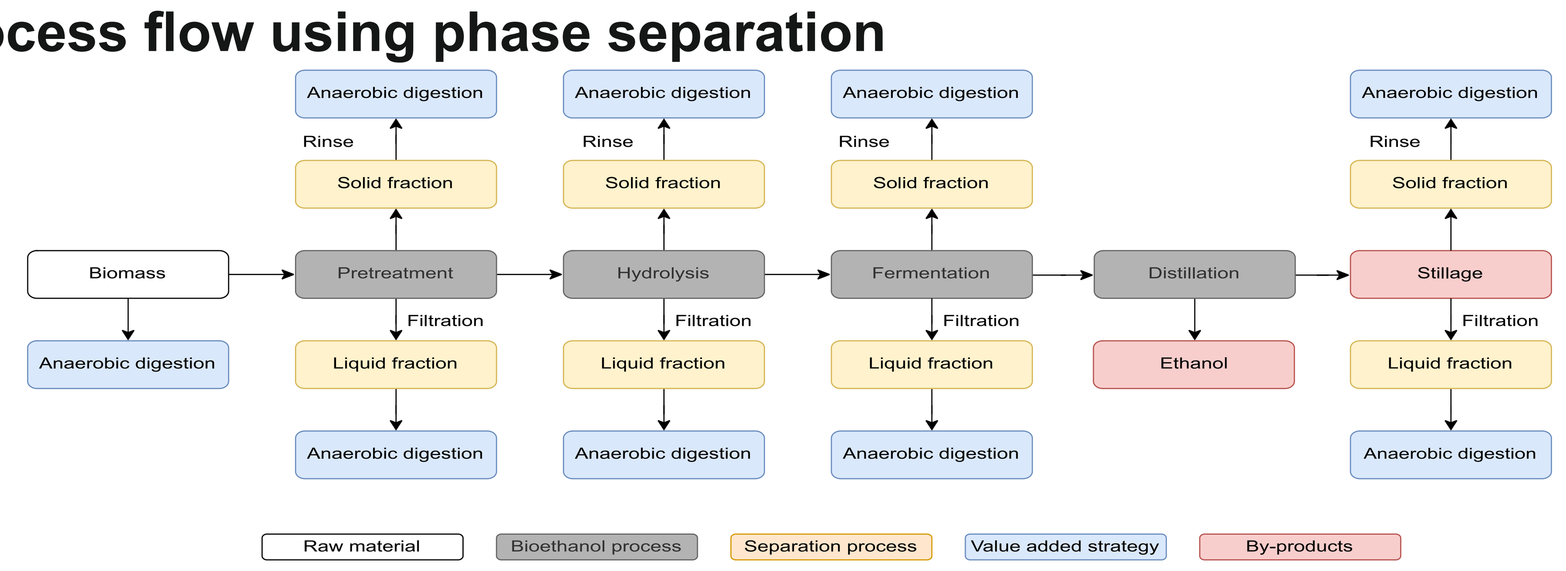
  b) High energy inputs are required to produce the fuel
- There is a continuous search for solutions to add value to the bioethanol production chain
- Anaerobic digestion has been proposed as a handling option for waste recovery from biodegradable waste and bioethanol sidestreams.

Methodology

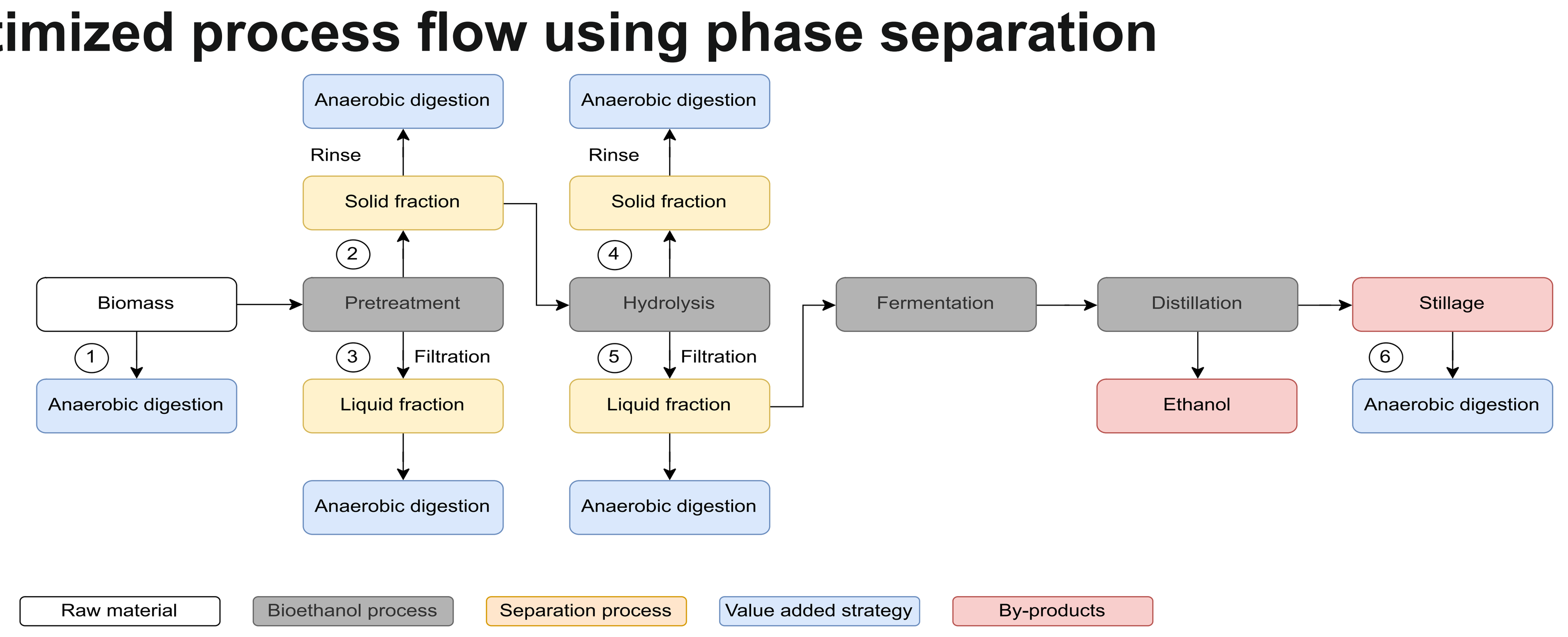
1. Traditional bioethanol process flow



2. Process flow using phase separation



3. Optimized process flow using phase separation

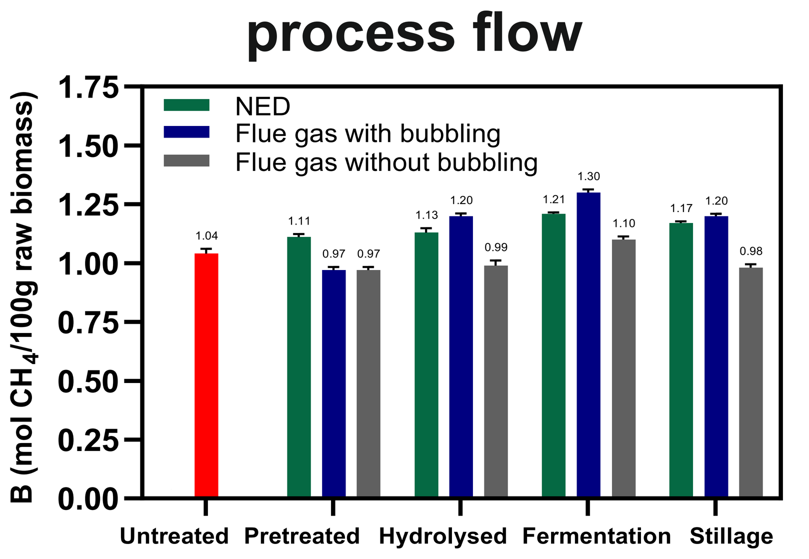


Objectives

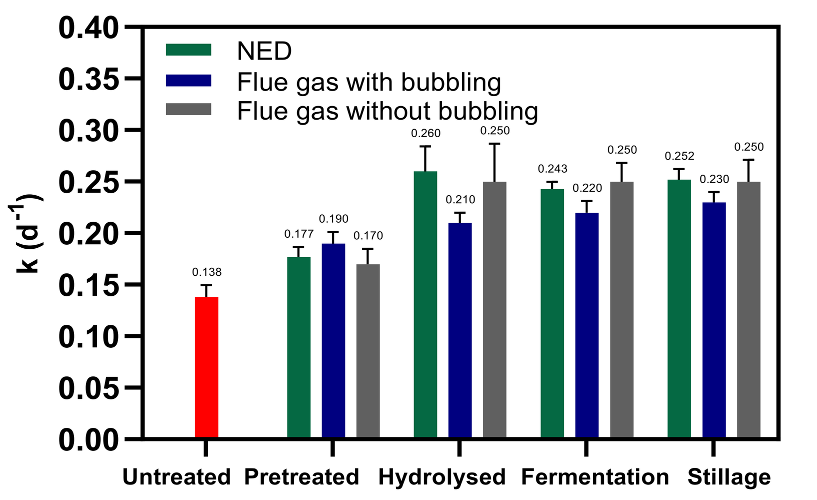
- Investigate the potential of agricultural sidestreams for bioenergy production.
- Study the strategies for sidestreams valorisation.
- Assess the potential of lignocellulosic residues for methane recovery.
- Analyse the influence NED and synthetic flue gas explosive decompression pretreatment methods in the methane recovery.
- Examine the performance of different feedstocks on methane yields.
- Evaluate the influence of different pretreatment temperatures in biomethane recovery.
- Explore different strategies to enhance the biomethane

Results

1. Traditional bioethanol process flow



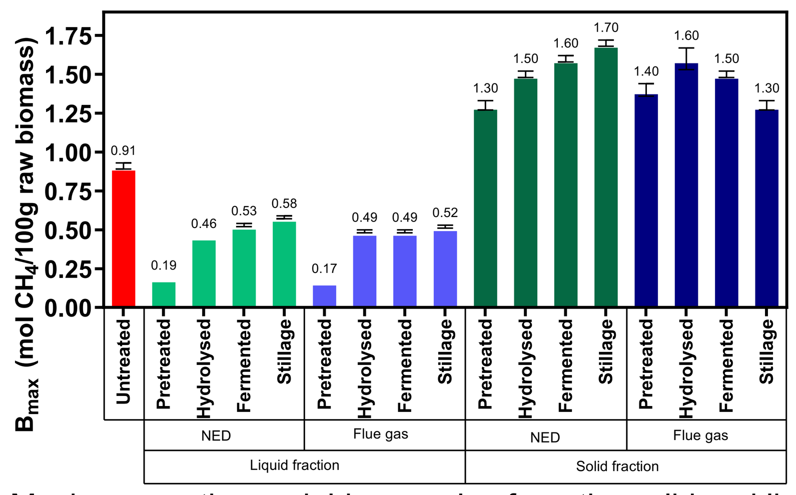
Maximum methane yield - samples pretreated with NED, flue gas (with and without bubbling) (barley straw).



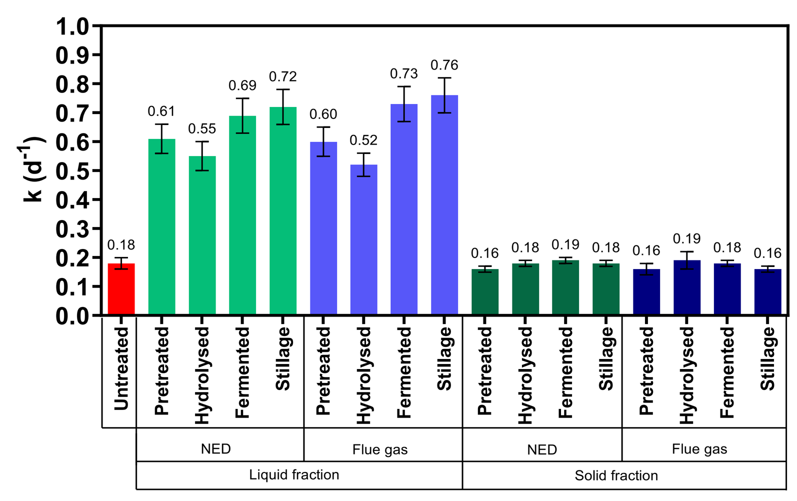
Kinetic rate constant - samples pretreated with NED, flue gas (with and without bubbling) (barley straw).

- Fermented samples have the highest biomethane yields, and untreated barley straw the lowest.
- Stillage is an extremely energetic residue that can be utilized to produce methane.

2. Process flow using phase separation



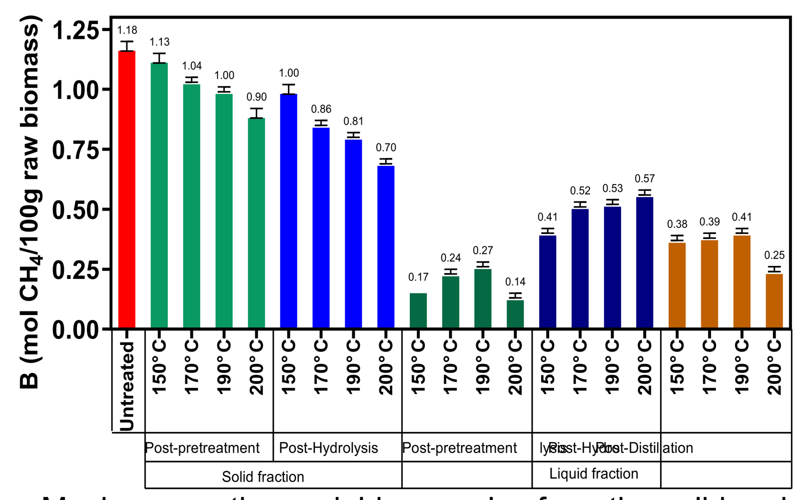
Maximum methane yield - samples from the solid and liquid fractions, pretreated with NED and flue gas (barley straw).



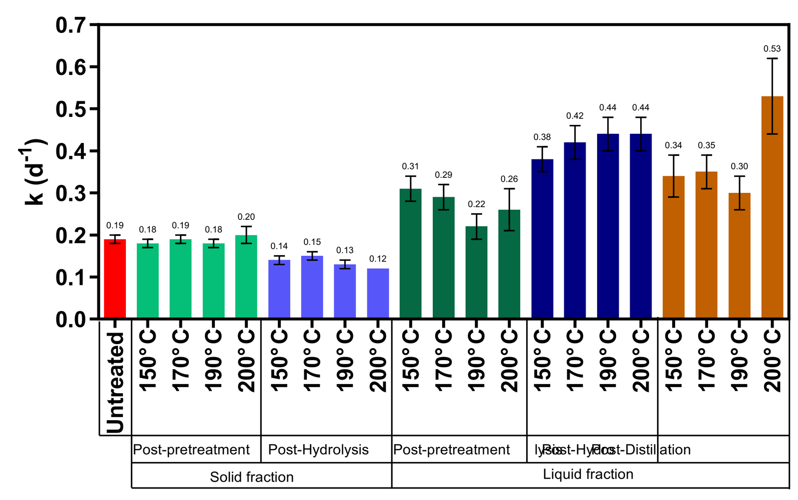
Kinetic rate constant - samples from the liquid and solid fractions pretreated with NED and flue gas (barley straw).

- Samples pretreated with NED had biomethane yields 8 % to 12 % higher than those pretreated with flue gas.
- Samples from the liquid fraction had biomethane yields 60 % to 80 % lower than samples from the solid fraction.

3. Optimized process flow using phase separation



Maximum methane yield - samples from the solid and liquid fractions (Napier grass).



Kinetic rate constant for the fitting curves of samples from the liquid and solid fractions (Napier grass).

- Bioethanol and biomethane yields are influenced by the pretreatment temperatures.
- Nigerian Pennisetum purpureum is a suitable feedstock for bioethanol and biomethane production in Nigeria.

Conclusions

1. Traditional bioethanol process flow

- NED and flue gas explosive decompression are effective pretreatment methods
- Sequential bioethanol and biomethane production is an effective solution for the production of value added products

2. Process flow using phase separation

- Biomethane yields of bioethanol stillage were improved by 45 %
- Phase separation is a promising solution to enhance bioenergy yields from sequential bioethanol and biomethane production.

3. Optimized process flow using phase separation

- Post-pretreatment samples (liquid fraction) should be separated and discarded since the biomethane yields are too low.

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