National Taiwan University

European Geosciences Union (EGU)

General Assembly 2026

Valorization of Okara using Hydrothermal Treatment in combination with Anaerobic Digestion for Resource Recovery

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National Taiwan University

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EGU26-2926

EGU26 GENERAL ASSEMBLY

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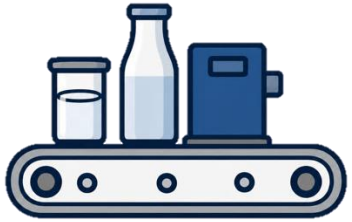
Background

Population growth

Industrialization

Okara
(Soybean residues)



Food processing
by-products

>14 million tons/year
worldwide

?

How can wet okara be converted into energy and value-added products without drying?

Integrated Conversion Pathway

Wet okara

Breaks down cellulose and protein into smaller molecules

Hydrothermal treatment

High temperature & pressure

a

Bio-crude oil

b

Hydrochar

c

Aqueous phase

Anaerobic digestion

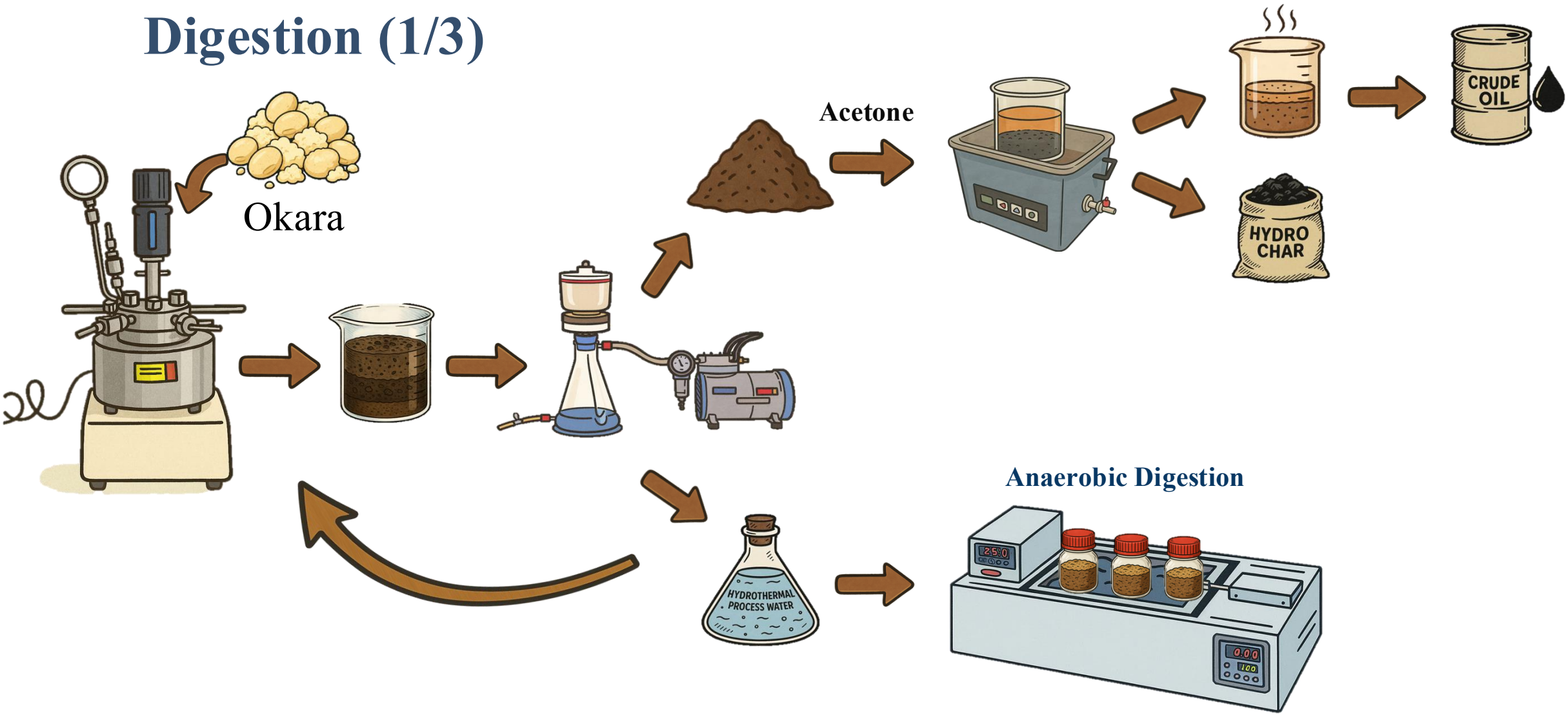
Methane-rich biogas

Research Objective

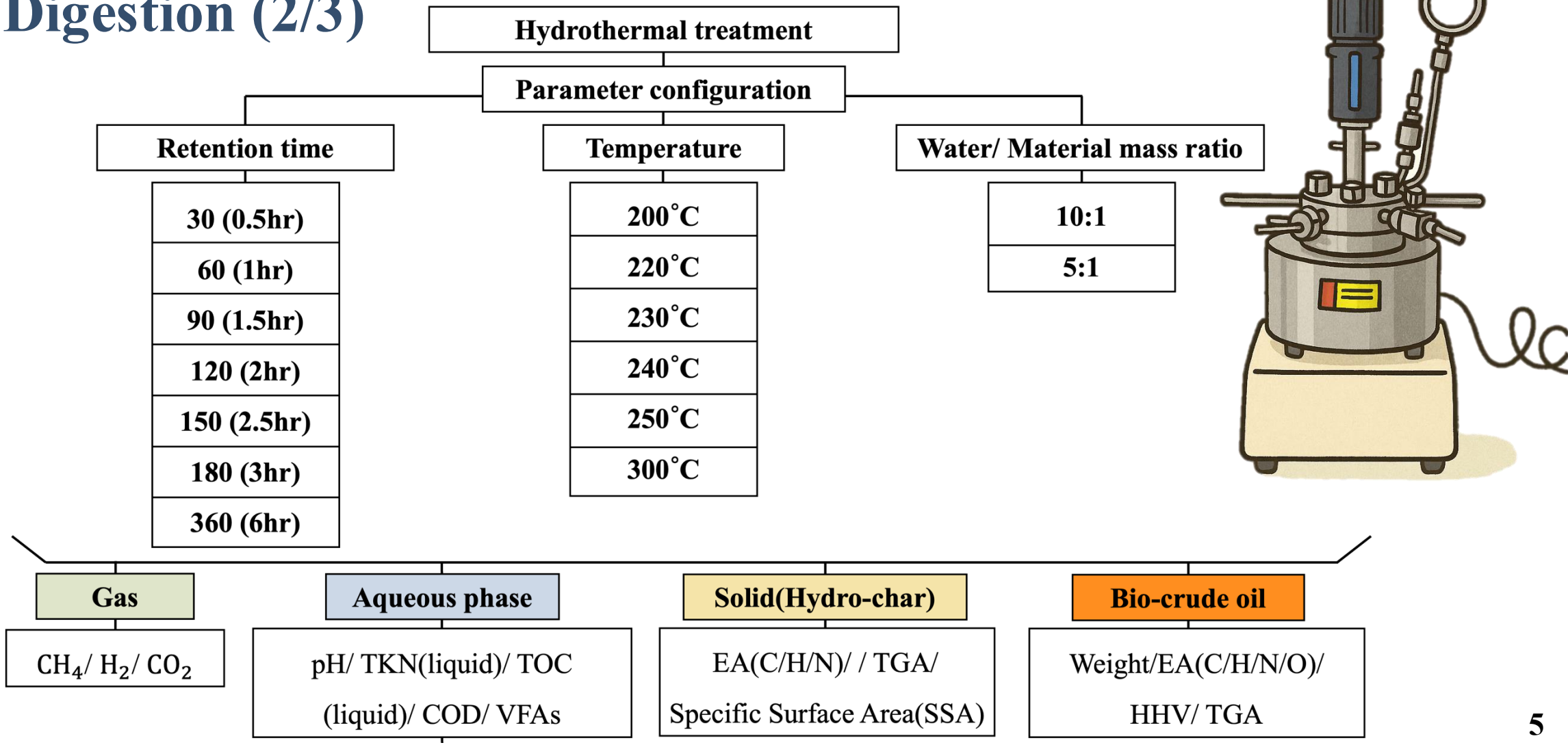
To develop an integrated HT–AD pathway for **improved energy recovery and circular resource utilization.**

Materials and Methods

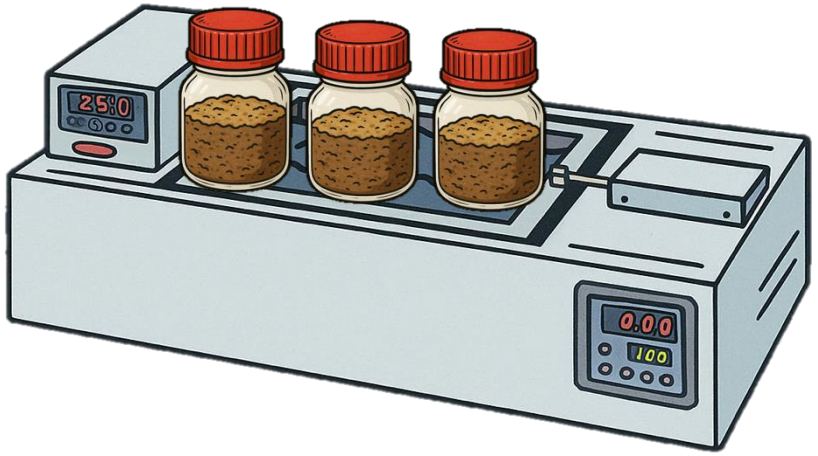
1.1 Hydrothermal Treatment combination with Anaerobic Digestion (1/3)



1.1 Hydrothermal Treatment combination with Anaerobic Digestion (2/3)



1.1 Hydrothermal Treatment combination with Anaerobic Digestion (2/3)



Hydrothermal Treatment Process - Aqueous phase

Anaerobic Digestion in 37˚C Water tank

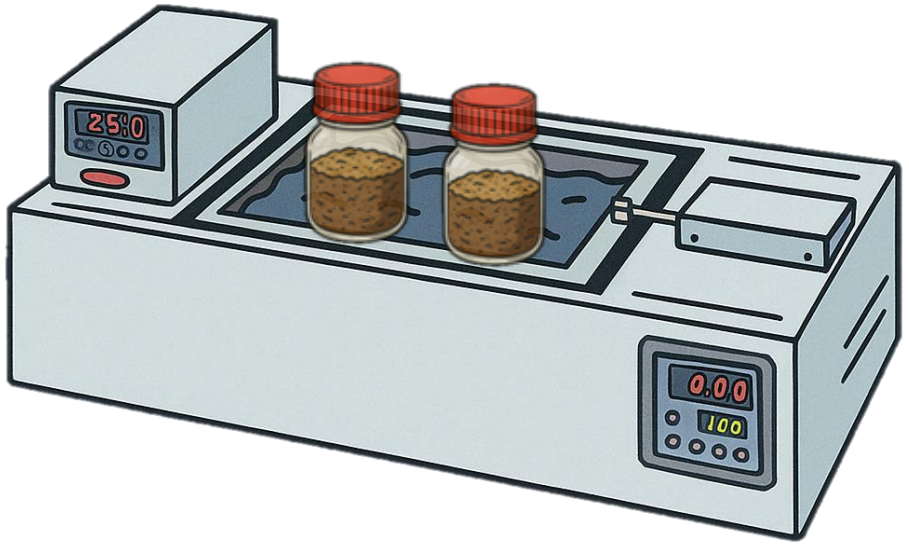
Parameter configuration

1:1 ratio of hydrothermal process water to sludge for co-fermentation

- Gas → CH_4/ H_2/ CO_2
- Liquid digestate → pH/VFAs
- Solid digestate → EA(C/H/N)/ TOC(solid)

1.2 Traditional Anaerobic Digestion Treatment : Okara with sludge

- **Raw sludge**
- **1:1 (Okara + sludge)**
- **5:1 (Okara + sludge)**



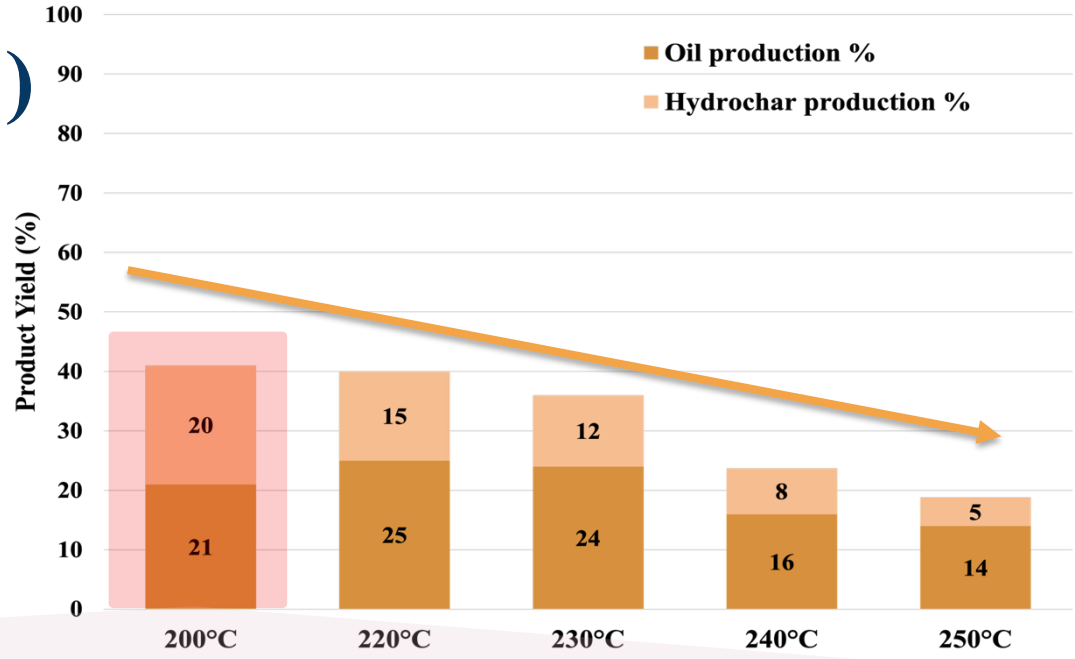
Experimental conditions :

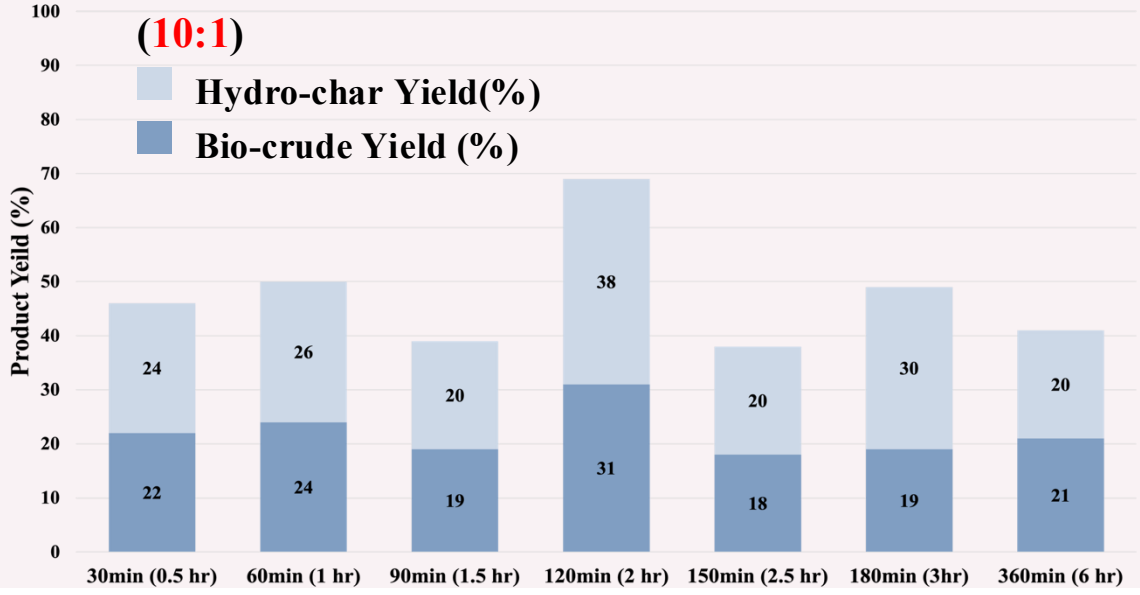
- Temperature: 37°C
- Conditional repetition - 3 times
- Period: 14 day

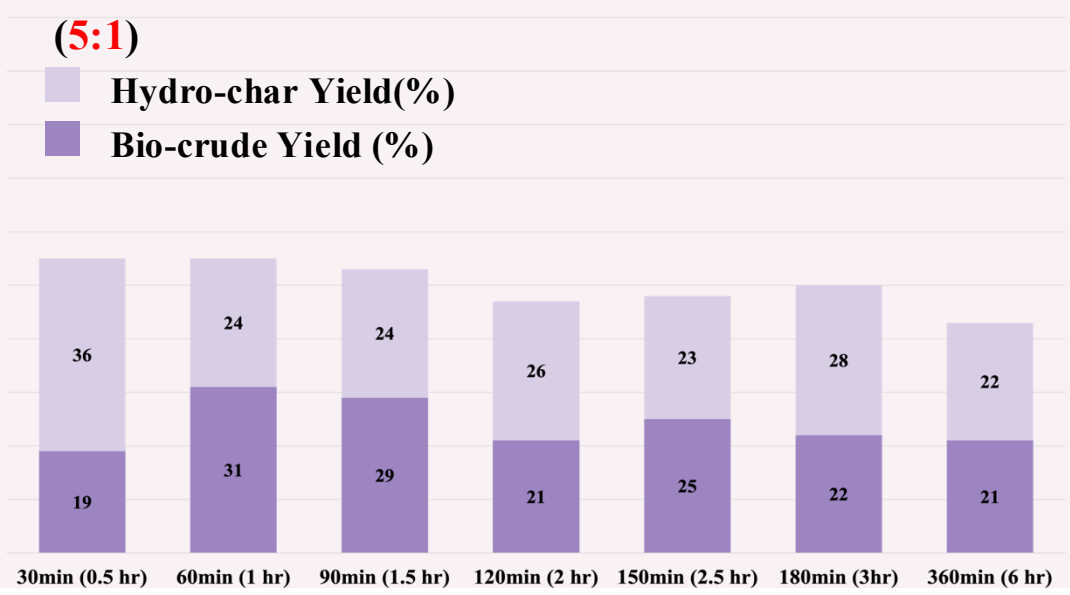
Key Results and Discussion

2.1 Hydrothermal Treatment(1/2)

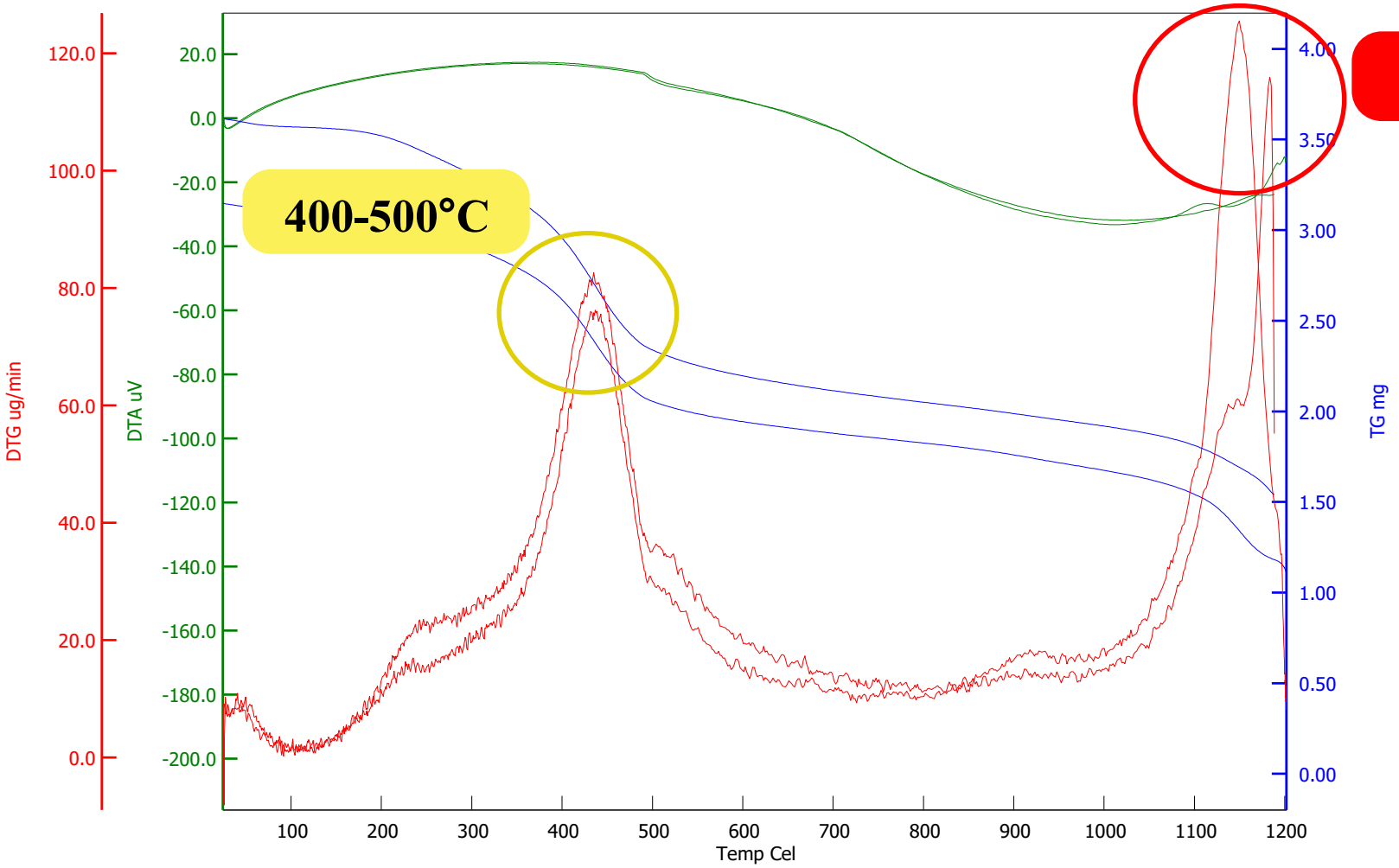
Temperature-Dependent Product Yield during 6-hour Hydrothermal Treatment





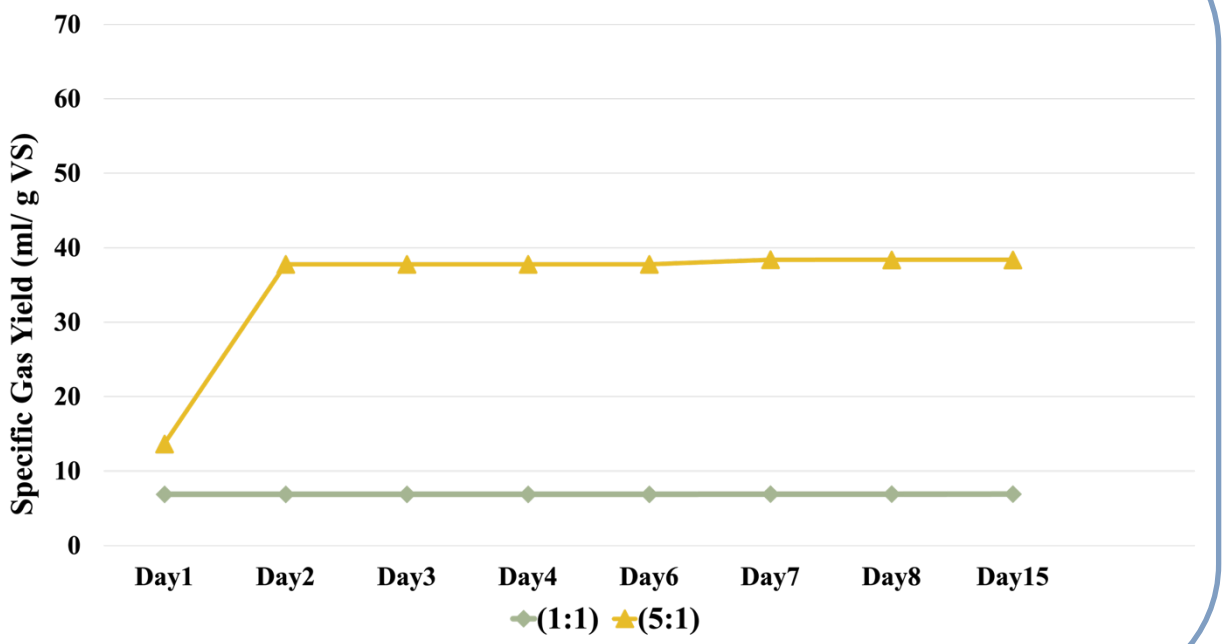


2.2 Thermal Stability Analysis of Derived Hydro-char



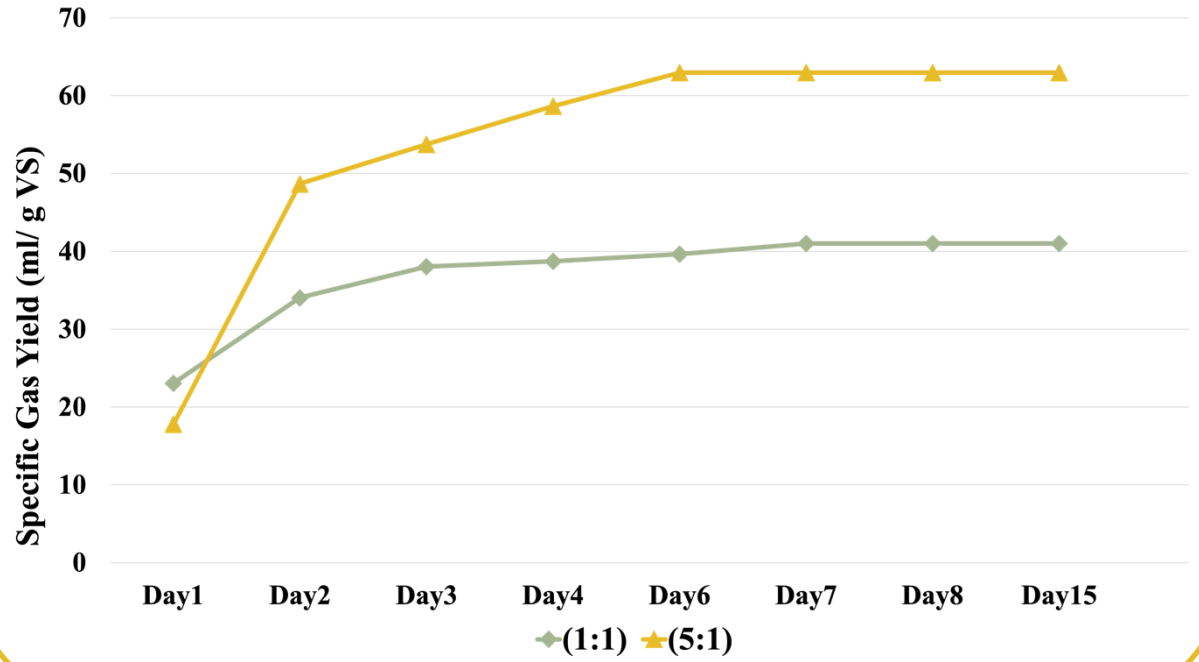
2.3 Traditional Anaerobic Digestion : Okara with sludge (1/2)

H_2 Yield



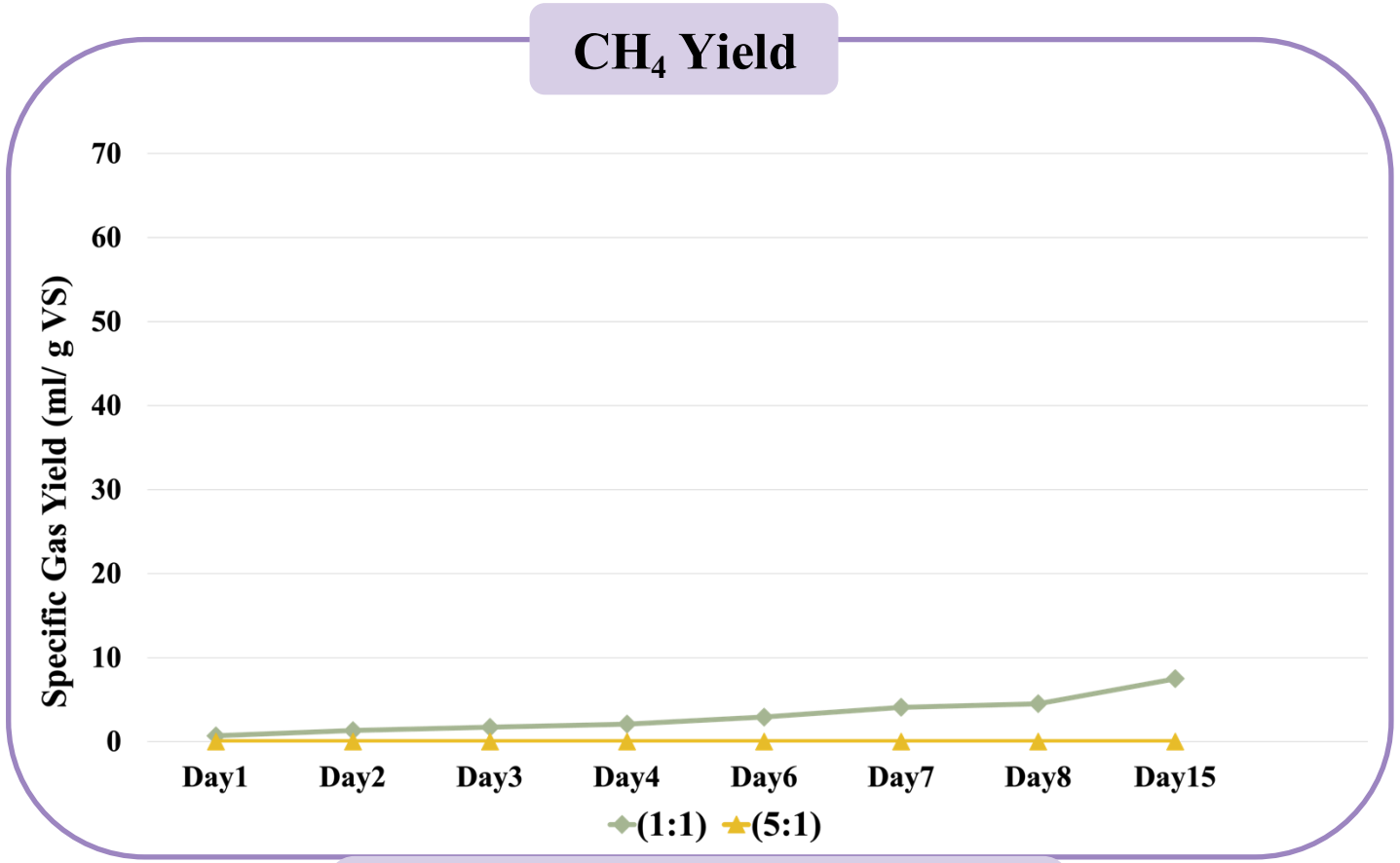
H_2 Yield → (5:1) > (1:1)

CO_2 Yield



CO_2 Yield → (5:1) > (1:1)

2.3 Traditional Anaerobic Digestion : Okara with Sludge (1/2)



Poor yield

H_2 Yield → (5:1) < (1:1)

Summary & Future Perspectives

3.1 Summary

- **Successful Valorization**

  HT effectively converted high-moisture agricultural waste into stable hydrochar and bio-oil without prior energy-intensive drying.

- **Enhanced Thermal Stability**

  TGA results confirmed that the derived hydrochar exhibits significantly higher thermal resilience, indicating its potential as a solid fuel alternative.

- **Tunable Yields**

  Modifying HT temperature and retention time allows for targeted optimization of solid and liquid product distribution.

3.2 Future Perspectives : Integration with Anaerobic Digestion

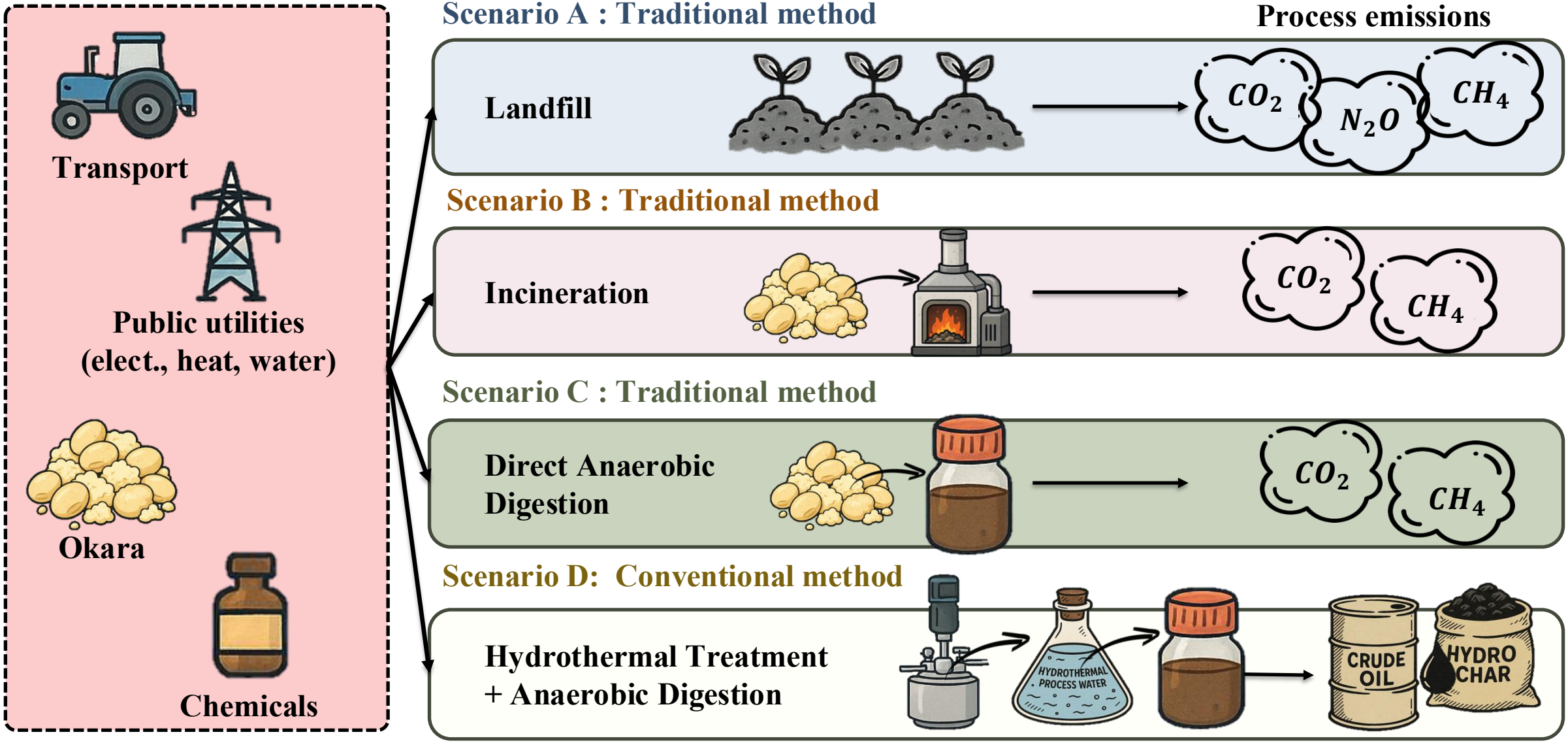
- **Inhibitor Assessment in Microbial Communities:**

  Analyze potential inhibitory compounds (e.g., furfurals, phenols) formed during HT and assess their toxicological impact on AD methanogens.

- **Energy Balance & Pilot-scale Evaluation:**

  Conduct a preliminary energy balance analysis of the combined HT-AD system to assess the feasibility of industrial scale-up.

3.3 Future Perspectives : Life Cycle Assessment



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Thank you for your listening

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