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Pretreatment of Organic Waste and Sewage Sludge for Biogas and Methane Production Improvement in Anaerobic Digestion in Hanoi, Vietnam

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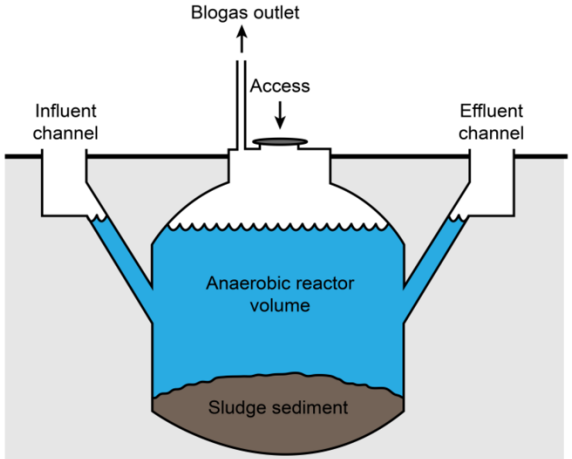
inspiring change

INTRODUCTION

- Rapid-growing population and urbanization in Vietnam, with increasing demand to treat produced municipal solid waste and sludge.
  - Current methods: Incineration, landfilling → Not optimum.
- Alternative method: Anaerobic digestion (AD)
  - Treat sewage sludge and organic municipal solid waste.
  - Limitations: Traditionally low efficiency (30-50%) and nonuniform biogas production performance among different waste resources.
  - Pretreatment methods can be performed to improve performance and biogas yield.



CHALLENGES

- Comprehensive research on hydrolysis improvement in Vietnam has not yet been achieved.
- Varying components of organic waste in municipal waste and sewage sludge for anaerobic digestion:
  - Low concentration of organic and degradable matter in sewage sludge resulting from combined sewage system in most Vietnamese urban areas.
  - High lignin and cellulose content in organic municipal waste, which are poorly digested by biological processes.
  - Human habits: traditional markets, diets, lack of garbage source-sorting.

RESEARCH OBJECTIVES

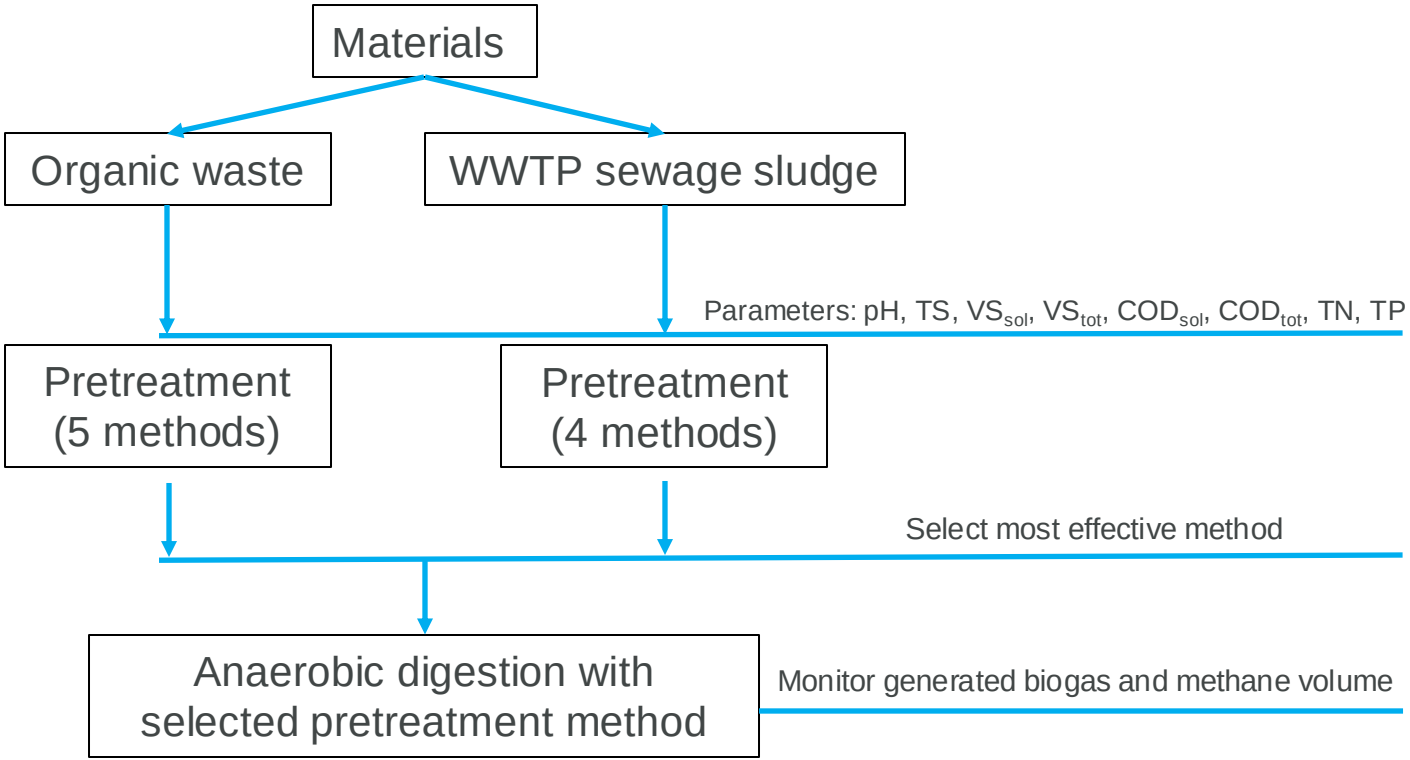
1. Determine the properties of organic municipal solid waste and sewage sludge in Hanoi, Vietnam.
2. Investigate the efficacy of five pretreatment methods on enhancing solubilization, biodegradability, and energy recovery ability of these waste streams.

MATERIALS AND METHODS

1) Sample collection

2) Evaluation of 5 pretreatment methods

3) Anaerobic digestion experiments



MATERIALS AND METHODS (CONT.)

- Materials:
  - Organic fraction of municipal solid waste collected from four farmers' markets in Hanoi, mixed homogenously.
  - Sewage sludge from the concentrated sediment tank in Bac Ninh WWTP, Hanoi.
  - Inoculum for AD tests from lab-scale 10 L anaerobic digester, grown for 1 year.



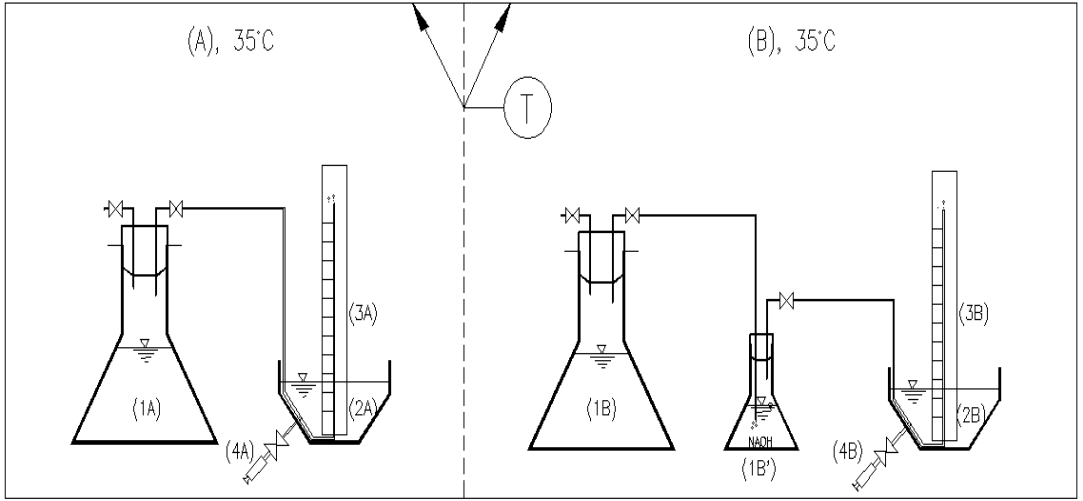

MATERIALS AND METHODS (CONT.)

- Pretreatment methods:

Mechanical	Thermal	Alkaline	Thermal Alkaline	Microwave
- Mix and grind substances with a blender (600W) for 15 minutes - Only for organic waste	90°C for 10 minutes	2M sodium hydroxide (NaOH) to reach pH = 8.5(±0.1)	- 2M sodium hydroxide (NaOH) at the start of autoclaving - 90°C and pH = 8.5(±0.1) for 10 minutes	Microwave (800W) for 30 seconds

MATERIALS AND METHODS (CONT.)

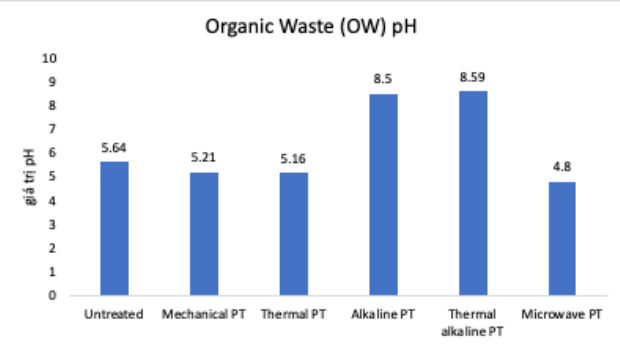
- Batch anaerobic biodegradability test:
  - Biogas (A) and methane (B) production measurement

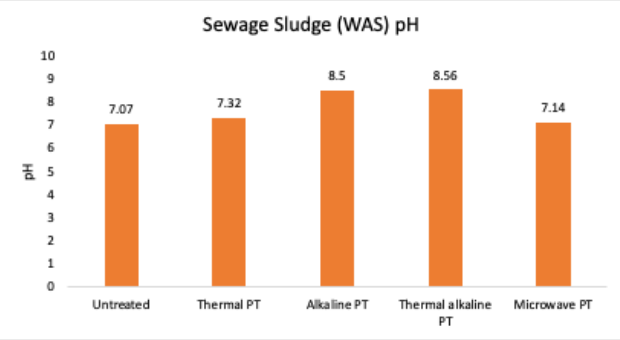


RESULTS

- Organic waste (OW) and wastewater sludge (WAS) characteristics:

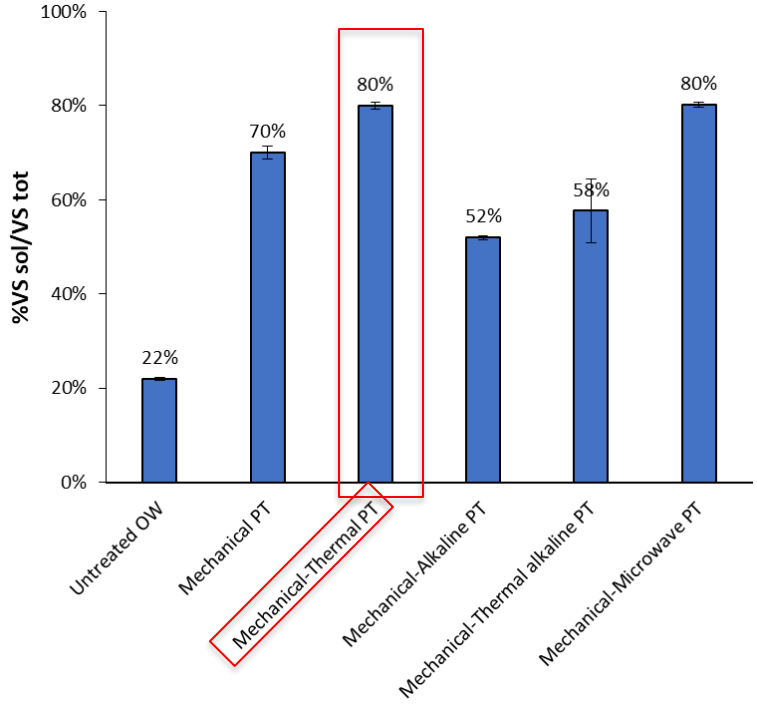
Parameter		OW	WAS
pH		5.6±0.1	7.1±0.1
TS	(g/kg)	142.2±0.5	20.2±1.5
VS	(g/kg)	128.4±0.8	14.6±0.2
VS_{sol}	(g/kg)	2.82±0.1	0.43±0.04
COD	(g/kg)	179.3±0.3	23.6±0
COD_{sol}	(g/kg)	2.86±0.08	0.24±0.02
TN_{sol}	(g/kg)	2.8±0	0.95±0
P (as PO_4^{3-})	(g/kg)	0.45±0	0.7±0

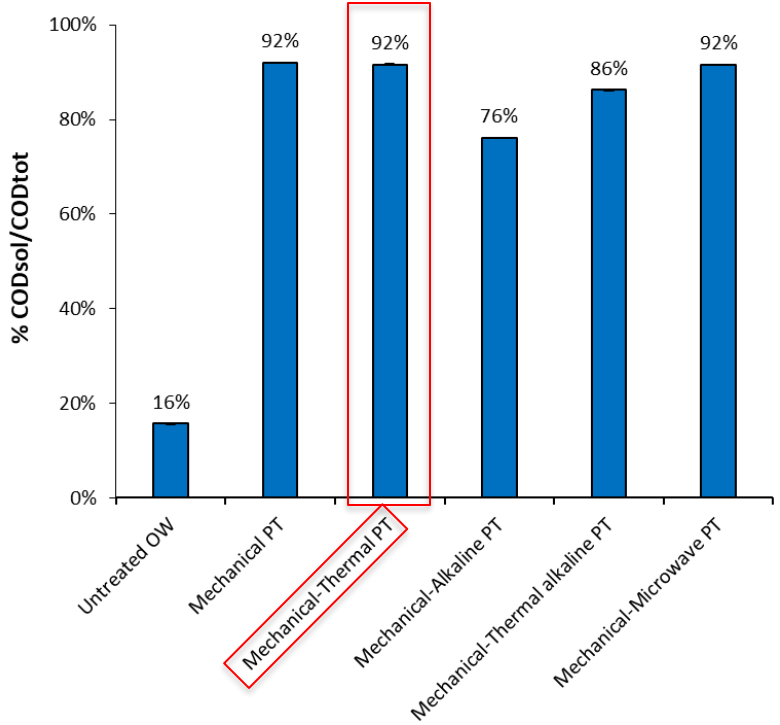




RESULTS (CONT.)

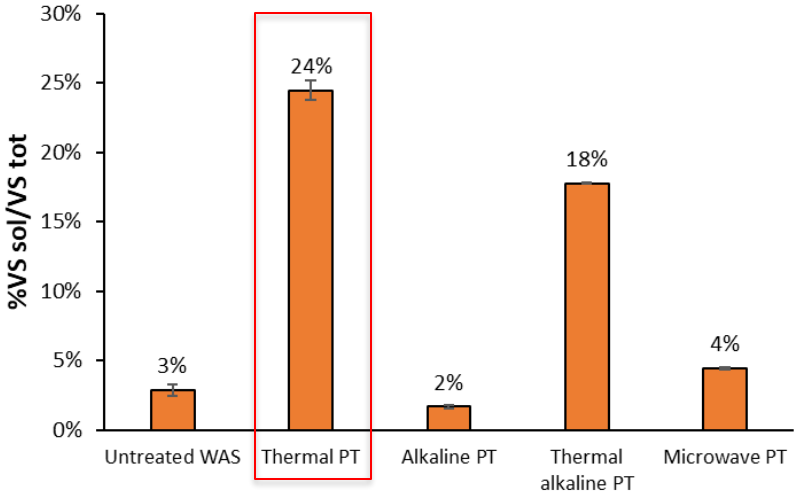
- Effect of pretreatment methods on OW solubility:

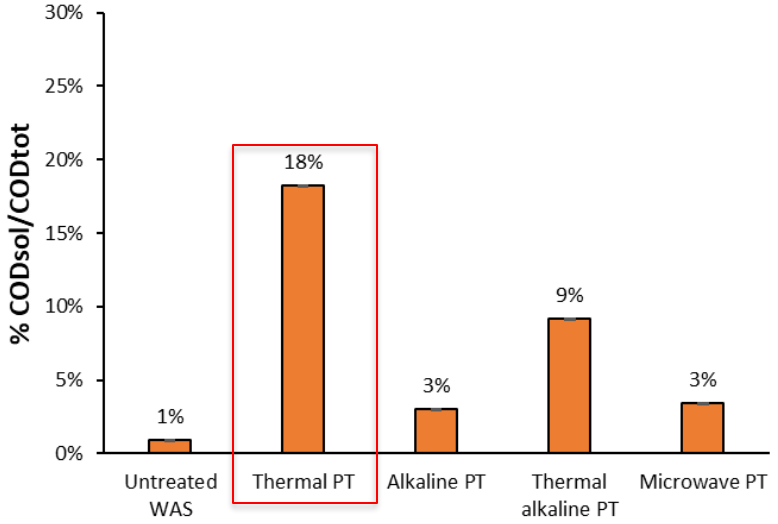




RESULTS (CONT.)

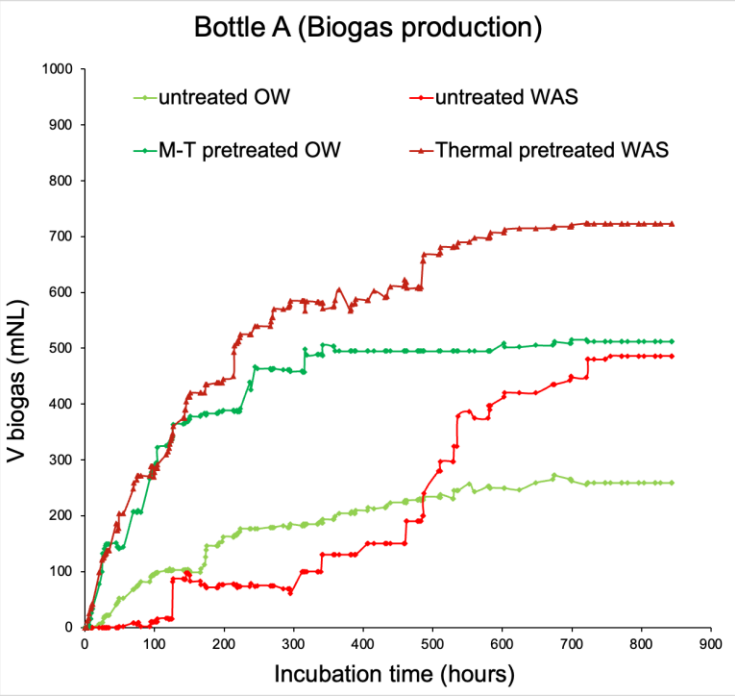
- Effect of pretreatment methods on WAS solubility:

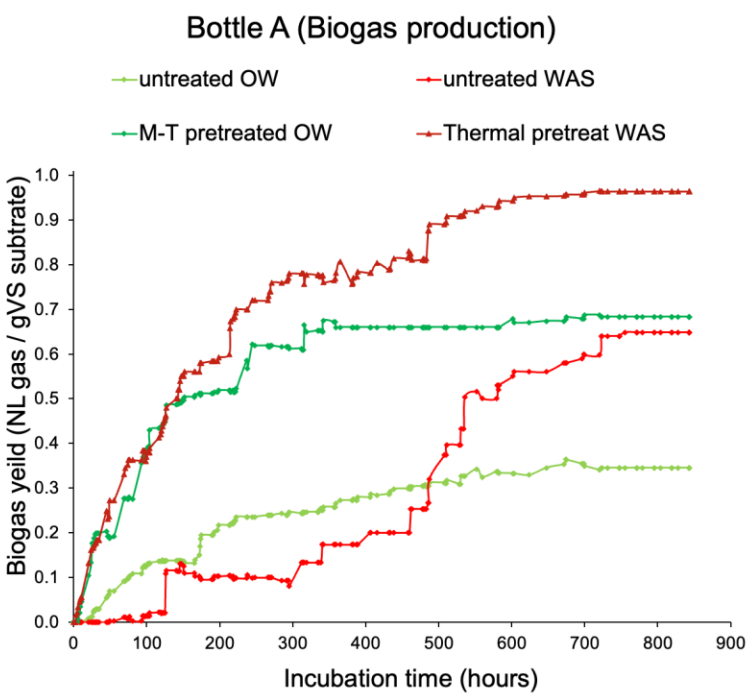




RESULTS (CONT.)

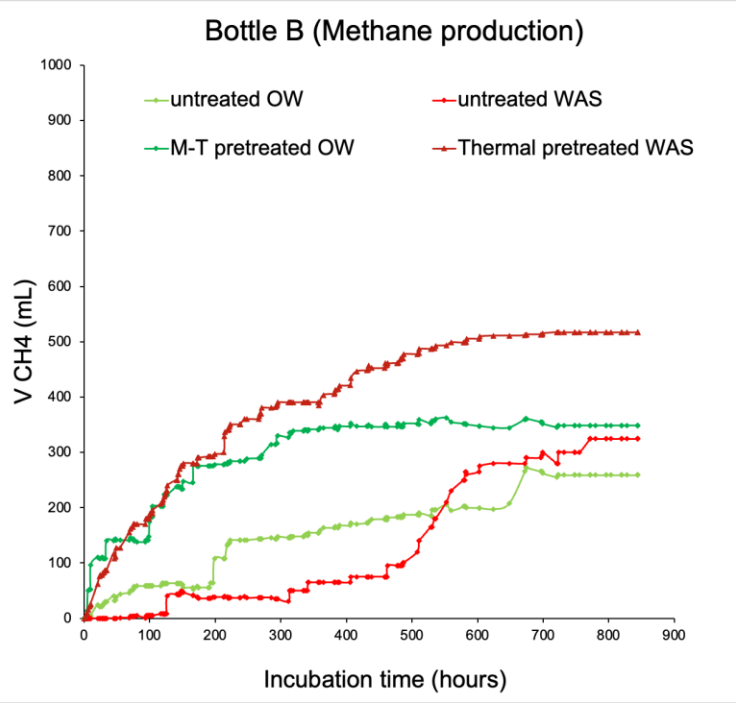
- Effect of pretreatment methods on biogas production:

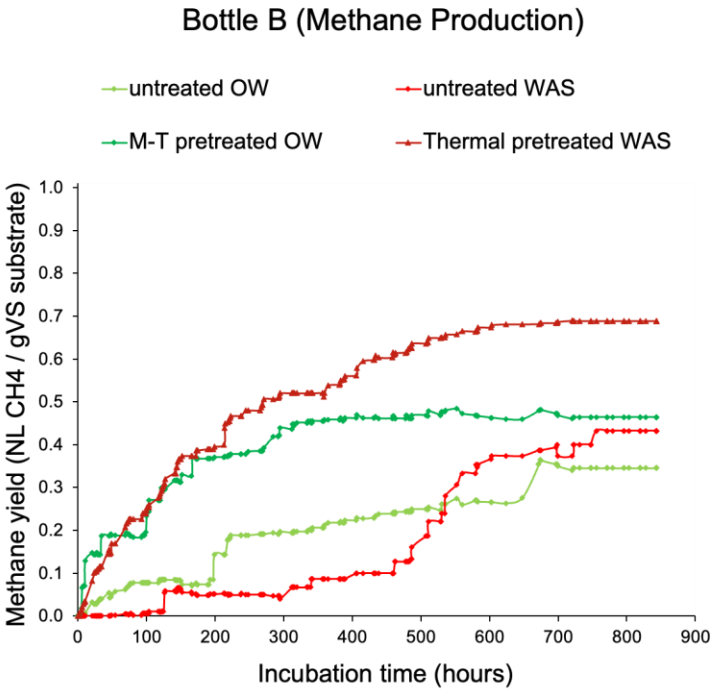




RESULTS (CONT.)

- Effect of pretreatment methods on methane production:





CONCLUSIONS

- All pretreatment methods increased the solubility of organic waste and sewage sludge, with thermal pretreatment was the most efficient out of the five methods investigated.
- Pretreatment methods did not affect the pH of samples.
- Application of OW and WAS pretreatment in anaerobic digestion increased biogas and methane production by 1.5 to 2 times.

➔ Pretreatment is recommended for enhancing energy recovery in anaerobic digestion of organic waste and sewage sludge.

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