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OÉ Gaillimh

Effect of total solids content on anaerobic co-digestion of pig manure and food waste under mesophilic condition

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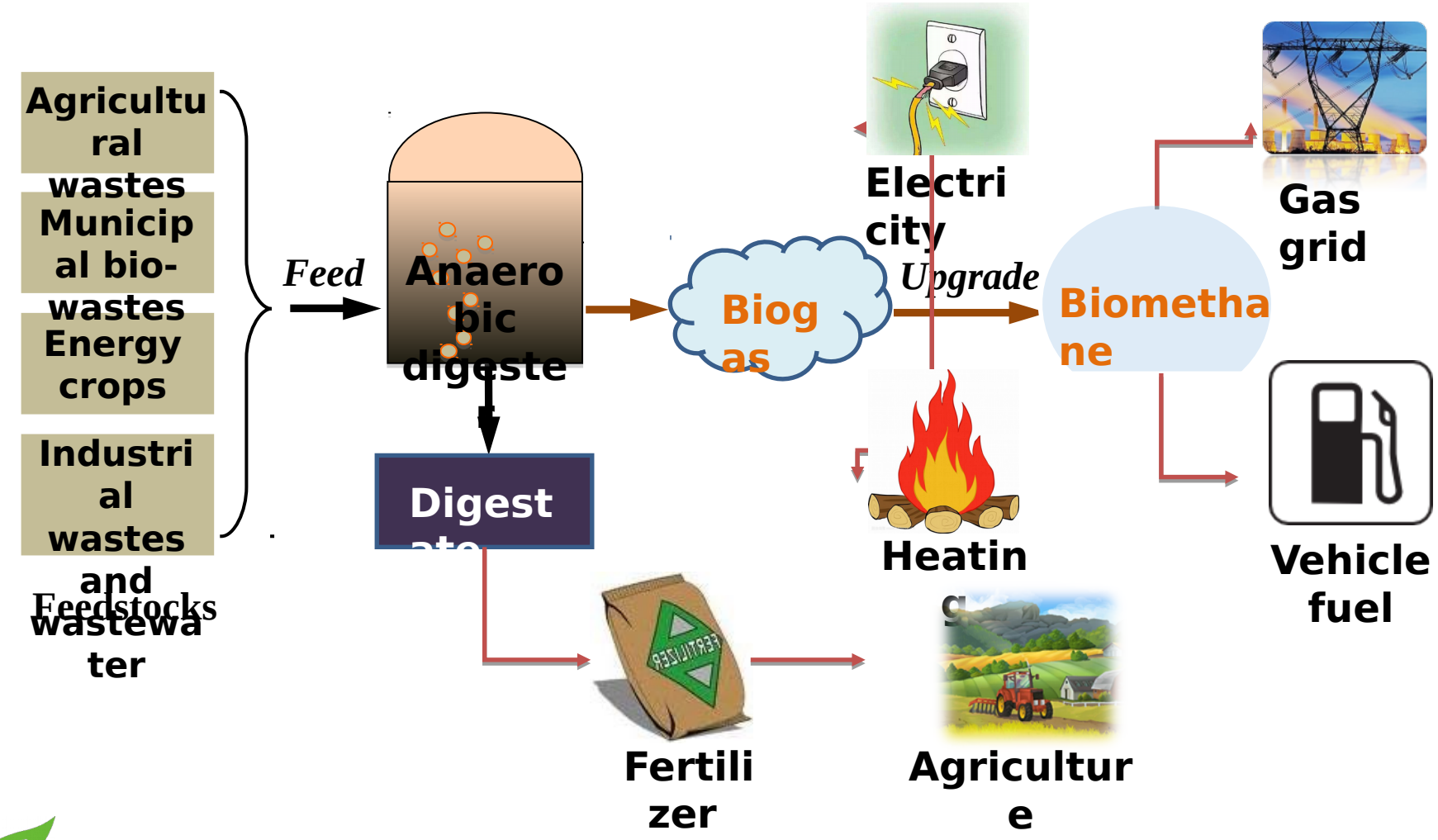
Background

- Renewable and eco-friendly technology — **Anaerobic digestion**



Background

- Wet and dry anaerobic digestion

❖ Wet/Liquid AD (with TS < 10%)

Conventional AD: usually operated with TS 2–6%*

Deficiencies

- High energy input requirement
- High cost for digestate post-treatment

Increased TS

❖ Dry AD(with TS ≥ 15%)

- An alternative to solve these problems.
- More attractive.

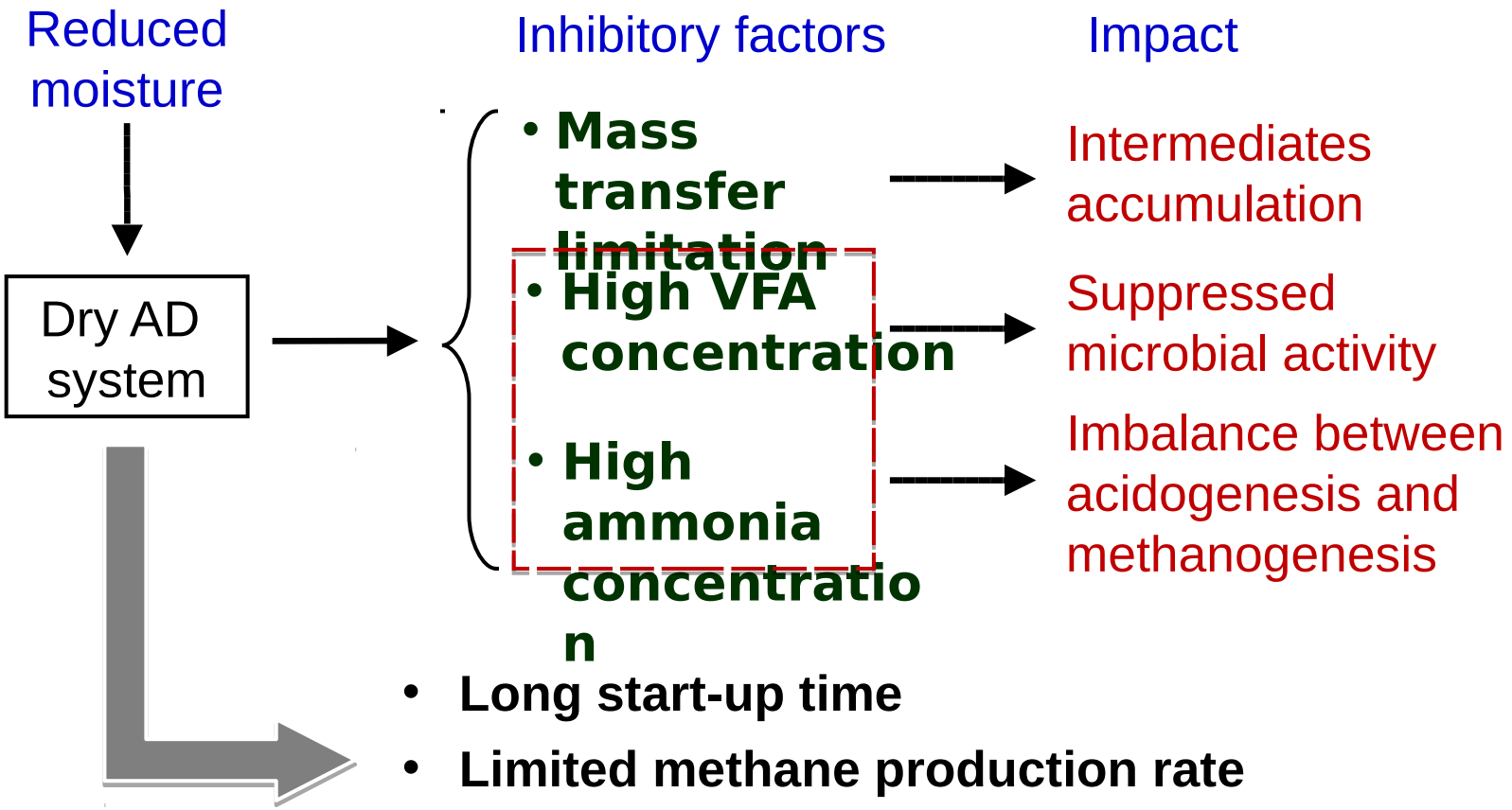
Advantages

- reducing digester size/volume.
- decreasing energy consumption for heating.
- avoiding high cost of liquid digestate management.
- producing methane-rich biogas.
- low consumption of water.

* Liu et al, 2016

Background

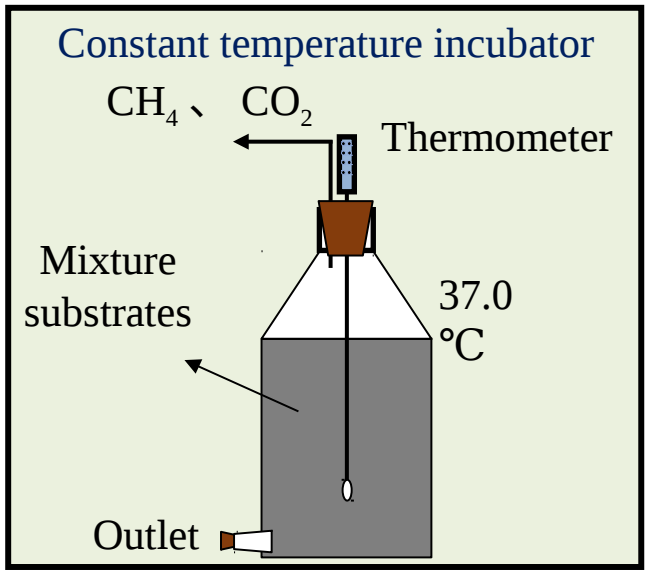
- Challenges for dry AD

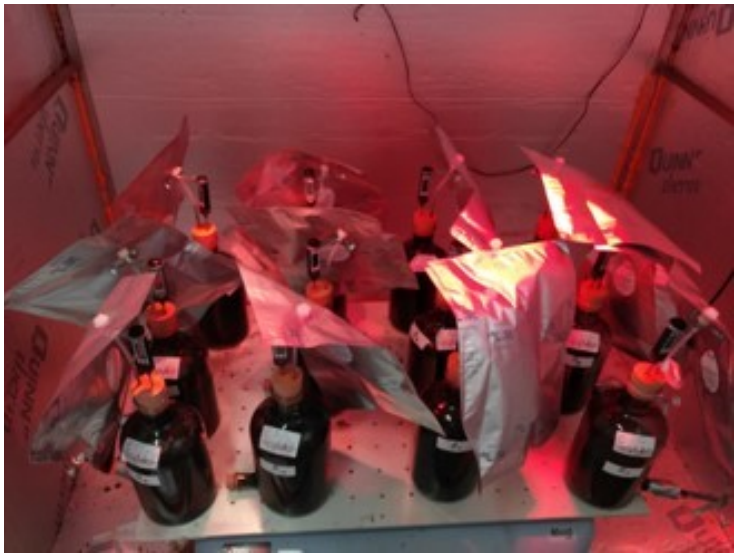


Methods and material

Experimental setup

- Total solids content: 5%, 10%, 15%, 20%.
- Substrates: Pig manure and food waste (PM/FW ratio of 25:25* by VS content).
- Reactors: R_1~R_{12}, 2 L Tap bottles (in triplicate at each TS content, 12 totally).
- Inoculum: Dewatered anaerobic sludge from a local municipal WWTP.
- Condition: Temperature 37.0 ℃; Shaken once by hand every day.





Schematic diagram of anaerobic reactors

*Jiang et al, 2018

Methods and material

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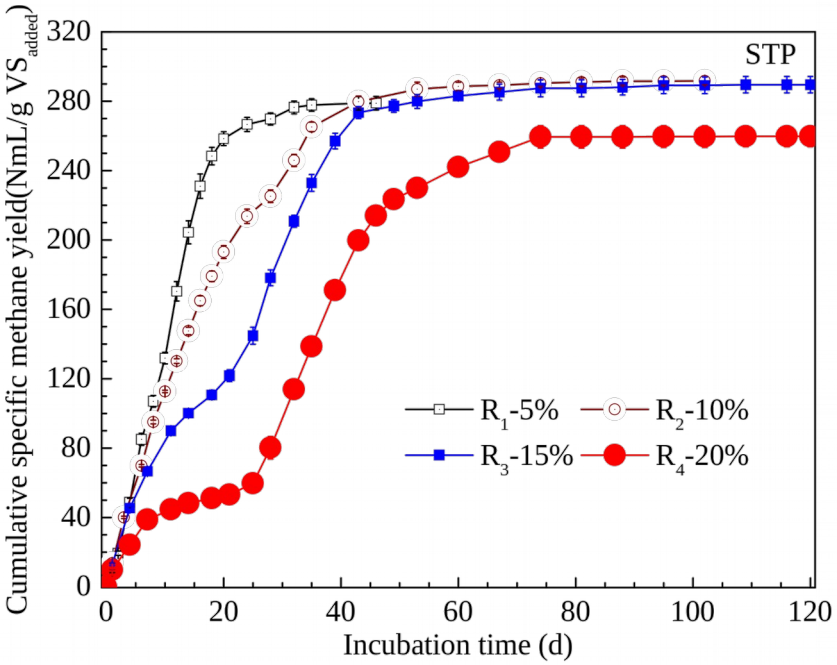
Characteristics of Substrates

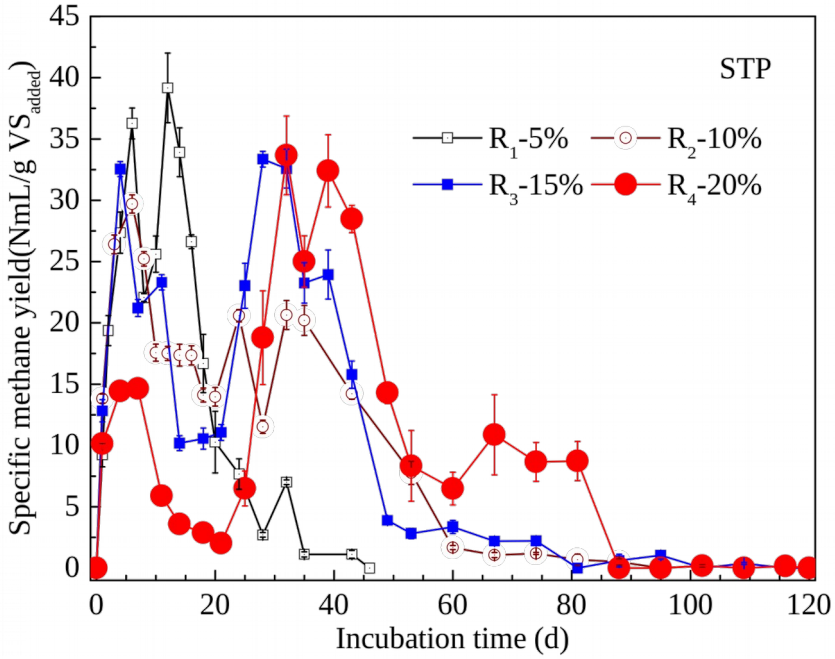
Physicochemical properties of PM and FW and seed sludge

No.	Characteristics	Solid fraction of pig manure	Food waste	Seed sludge
1	pH	**7.57±0.03**	**4.93±0.02**	**7.77±0.03**
2	Moisture content (MC, %)	**77.1±0.01**	**59.5±0.38**	**80.0±0.05**
3	Total solids (TS, %)	**22.90±0.01**	**40.52±0.38**	**20.02±0.05**
4	Volatile solids (VS, %)	**17.93±0.01**	**39.96±0.30**	**13.76±0.08**
5	VS/TS (%)	**78.4**	**96.2**	**68.7**
6	SCOD (g/L)	**40.9**	**126.8**	**7.1**
7	TCOD (g/L)	**197.6**	**271.4**	**190.1**
8	Total volatile fatty acid (VFA, mg Acetate/L)	**24 035.9**	**8794.0**	**0**
9	Total ammonia nitrogen (TAN, mg/L)	**4156.3**	**240.2**	**1793.3**
10	Free ammonia nitrogen calculated (FAN, mg/L)	**85.76**	**0.01**	**57.94**

Results and discussion

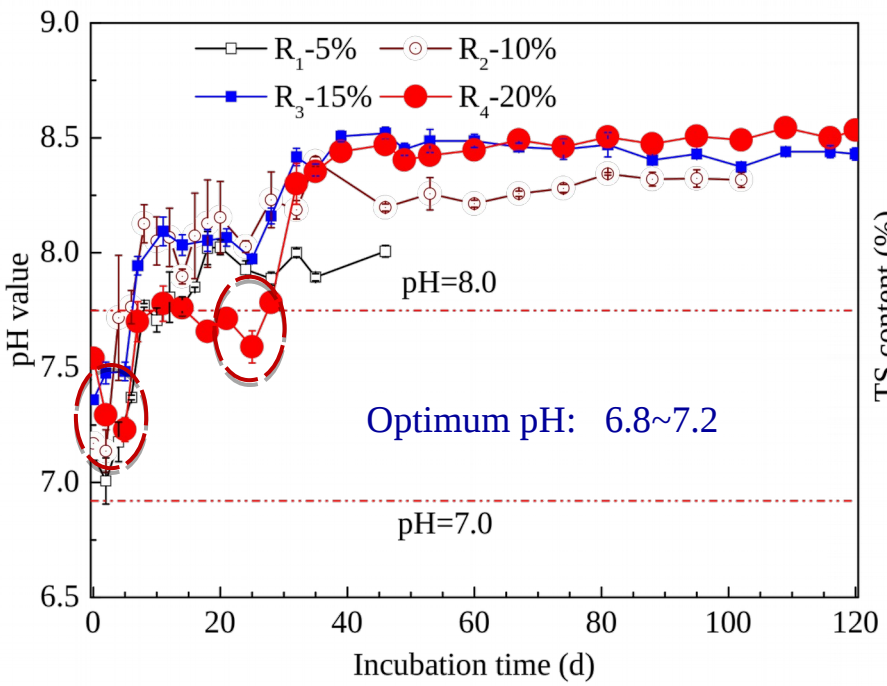
Biomethane production

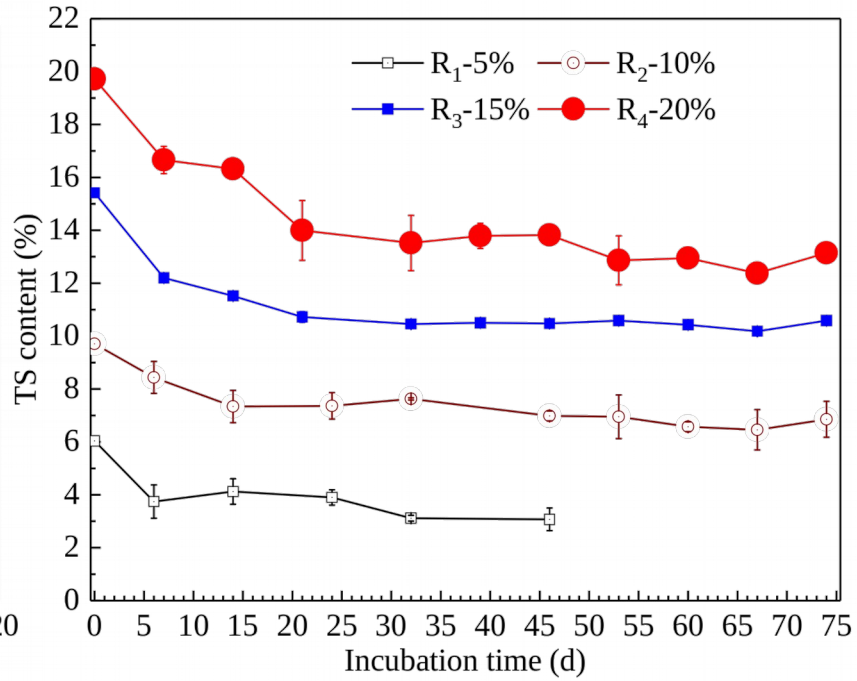




- 20%-TS digesters obtained a relatively-low SMY
- Prolonged lag phase with the increase of TS, especially with 20%-TS
- Two peaks occurred during digestion

4 Results and discussion





- A lower pH value around 7.5 occurred in R_4-20% before day 25.
- pH values were all within the acceptable range of 6.5-8.5.
- More time was needed for R_4-20% before reaching a constant TS

Results and discussion

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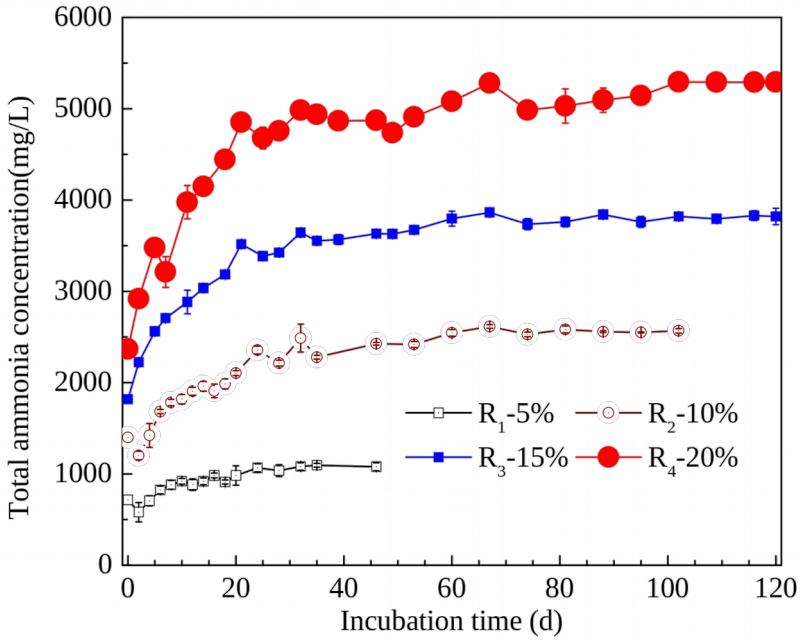
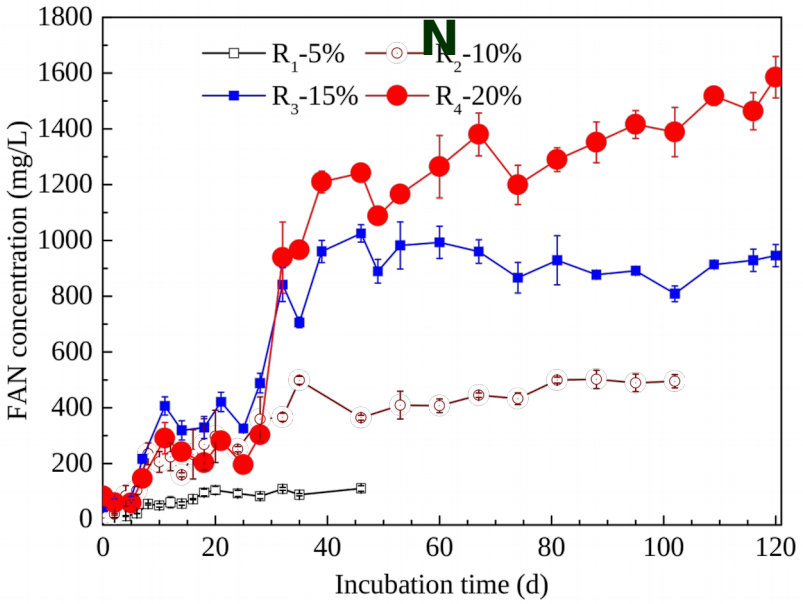
TAN concentration



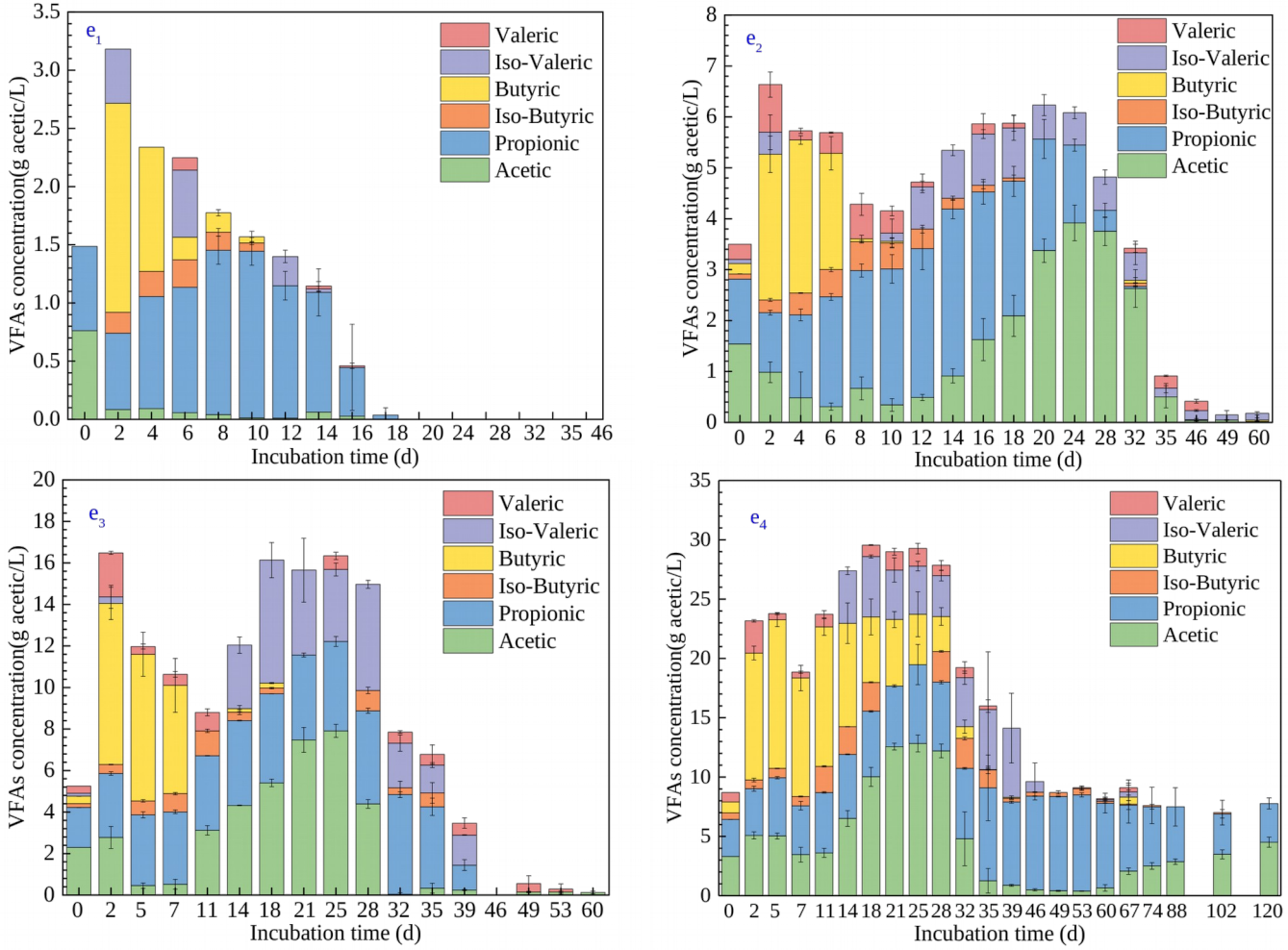
FAN



- The release of ammonia proceeded rapidly at the beginning according to the steep increment tendency
- At fisrt several days, FAN increased distinctly due to the rapid release of ammonia.
- The inhibition of free ammonia on methanogens occurred in TS-15% and TS-20% digesters (FAN up to 400 mg-N/L)

Results and discussion

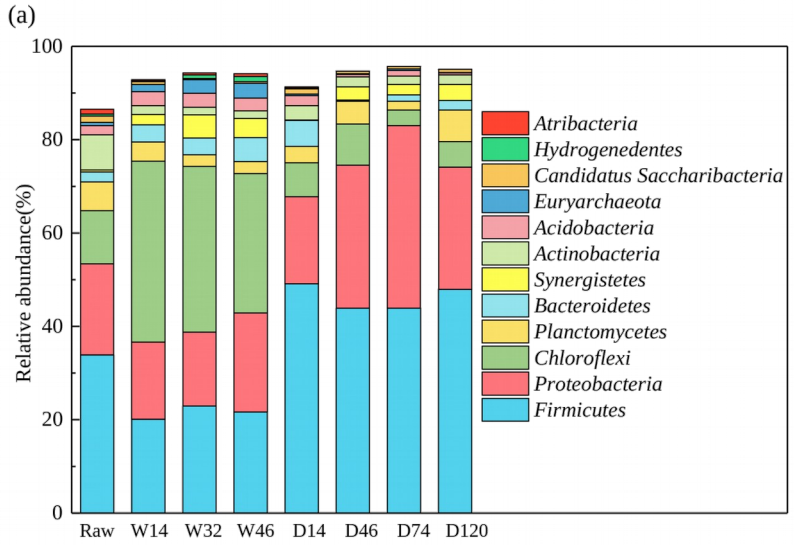
VFA concentrations



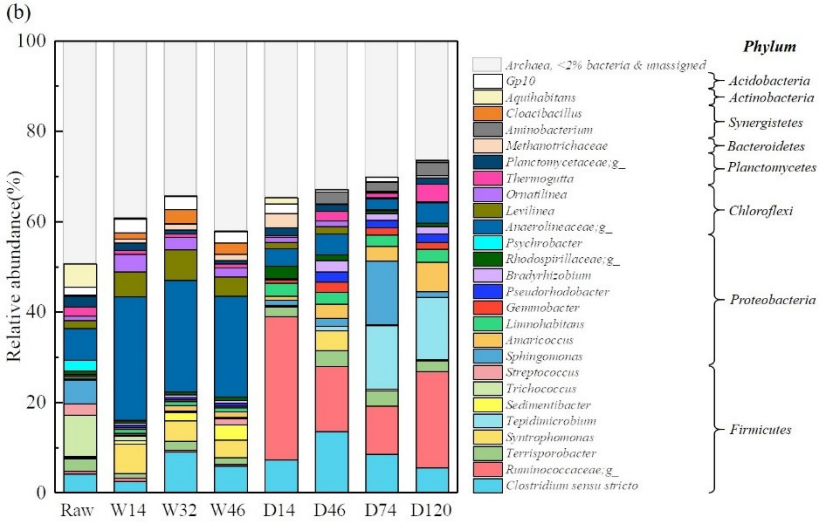
Results and discussion

Microbial community analysis

At the phylum level

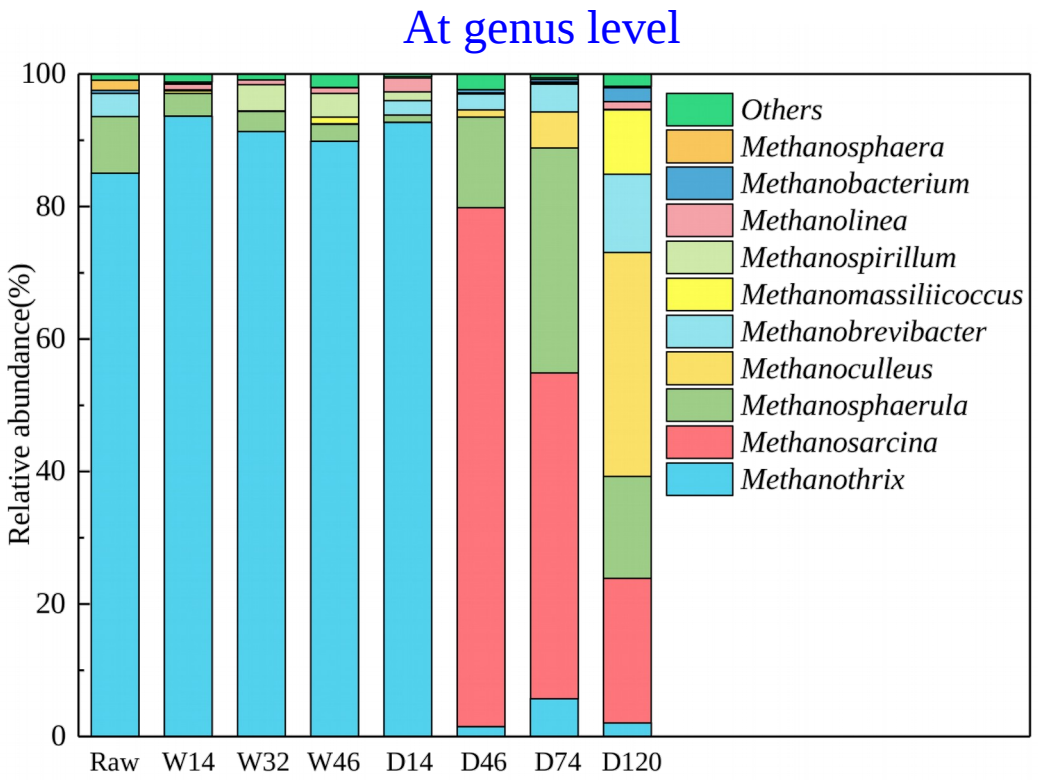


At genus level



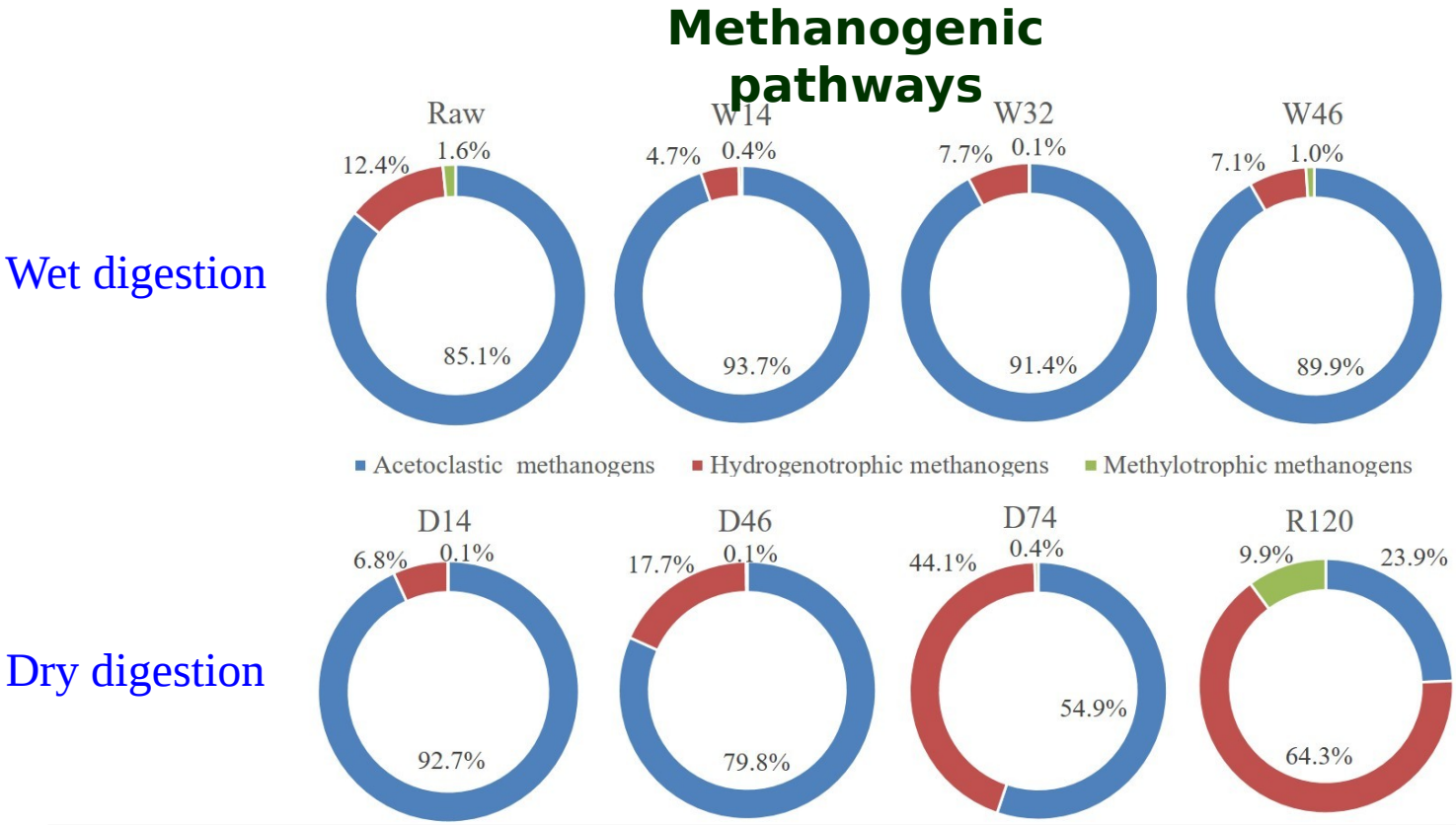
- Phyla *Firmicutes* (43.9-49.1%), *Proteobacteria* (18.6-39.1%), *Chloroflexi* (3.3-8.8%) and *Planctomycetes* (1.9-6.8%) dominated in dry digesters.

Results and discussion



- No big change in wet AD, *Methanothrix* was dominant.
- On day14, microbial community in dry AD is similar with wet AD, and shifting occurred in dry AD with the incubation time.
- *Methanosarcina* was predominant in dry AD, followed by *Methanosphaerula* and *Methanoculleus*.

Results and discussion



- Hydrogenotrophic methanogenesis gradually increased along with the incubation time in dry AD.
- The dominance of *Methanosarcina*, *Methanosphaerula* and *Methanoculleus* might be responsible for the enhanced resistance capacity in dry AD.

Conclusion

- 20%-TS digesters obtained a relatively-low SMY, and prolonged lag phase.
- Hydrogenotrophic methanogenesis gradually increased and was dominant in the dry AD process.

Thank you!

Thank to Science Foundation Ireland for financially supporting our research

Gas Networks Ireland

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