5th International Conference on Sustainable Solid Waste Management-ATHENS2017
24-27 June, 2017

Comparison of single-stage and temperature-phased anaerobic digestion of sugar beet by-products

Kaoutar Aboudi*, Xiomara Gómez Quiroga, Carlos José Álvarez Gallego and Luis Isidoro Romero García

Chemical Engineering and Food Technology Department, University of Cádiz, Campus Río San Pedro, 11510 Puerto Real, Spain

*kaoutar.aboudi@uca.es

22 June 2017

Contents

- BACKGROUND
- EXPERIMENTAL STRATEGY
- RESULTS AND DISCUSSION
- CONCLUSIONS

UCA Universidad de Cádiz

Lignocellulosic biomass

1 tonne of Sugar beet processed → 70 kg of exhausted dried pulp
≈ 250 kg of exhausted pressed pulp

Total global production in 2014
267 Mt

20 Mt of dry SBP

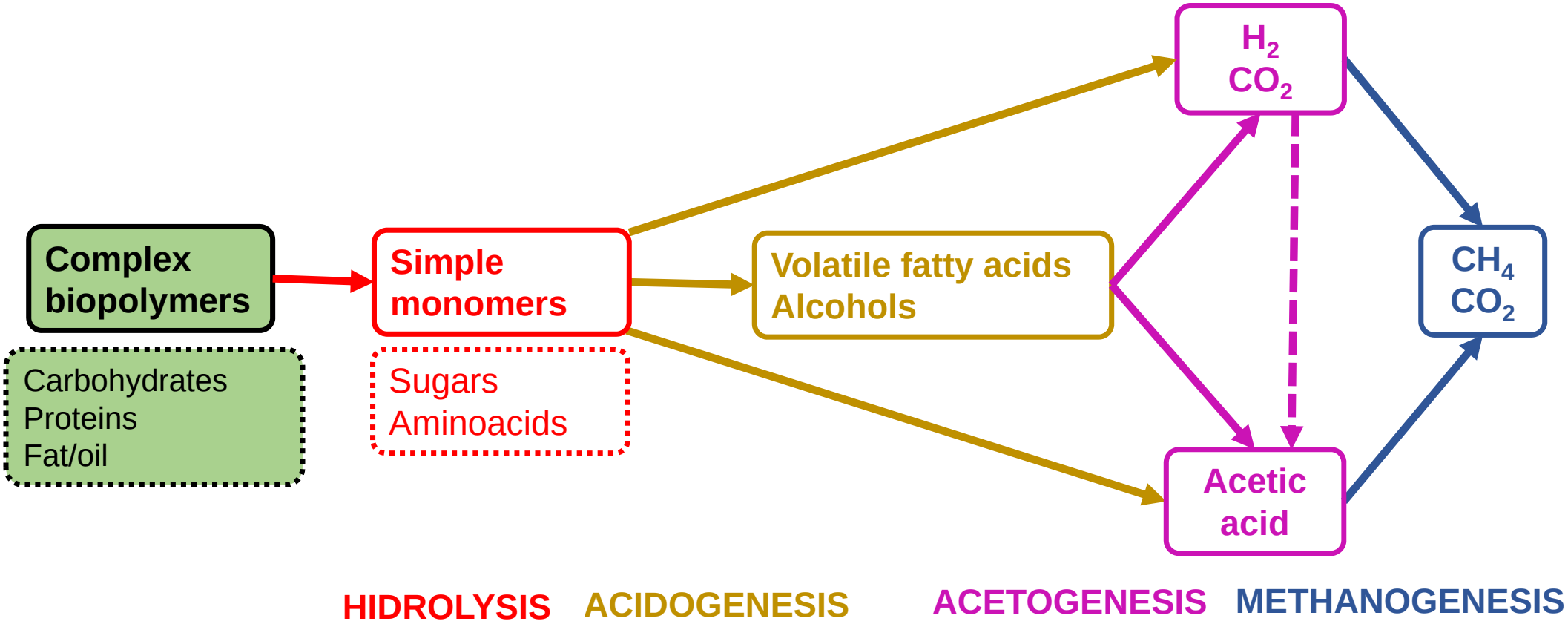
Animal feedstock supplement

UCA Universidad de Cádiz

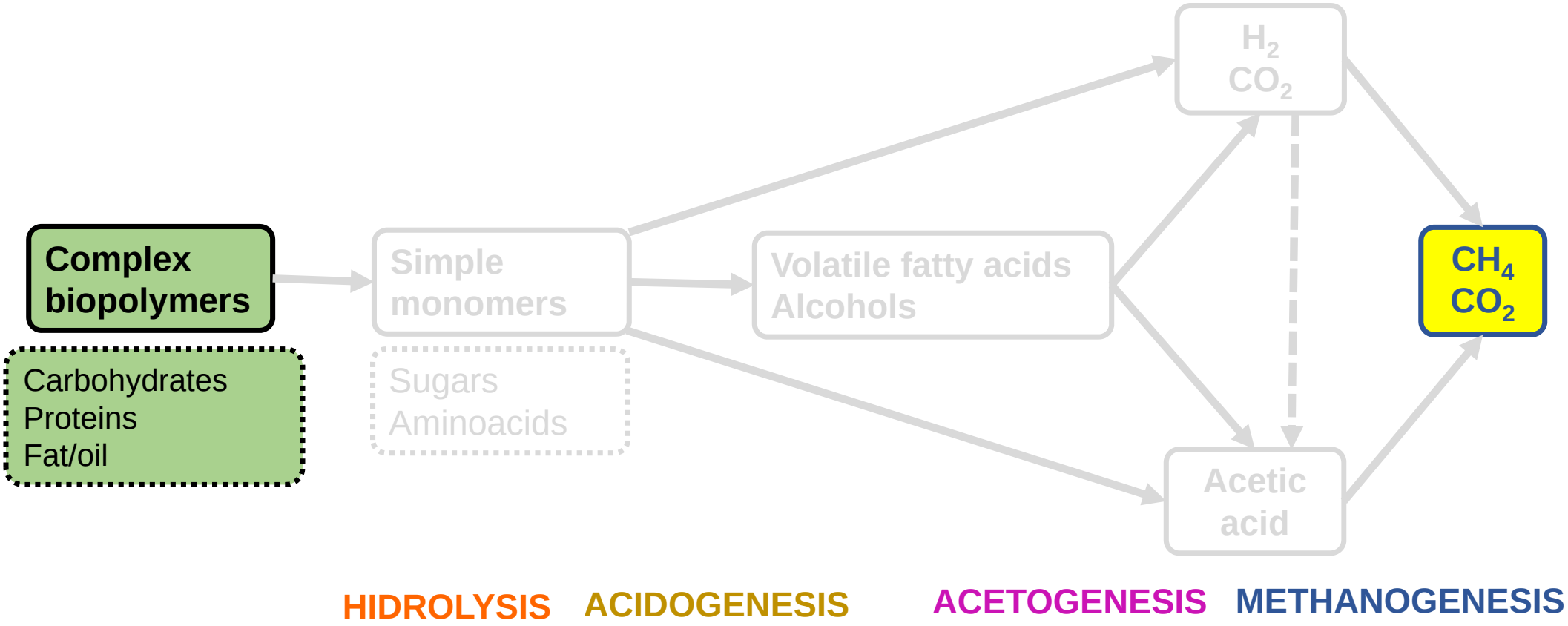
Lignocellulosic biomass

Bioenergy = Anaerobic digestion technology

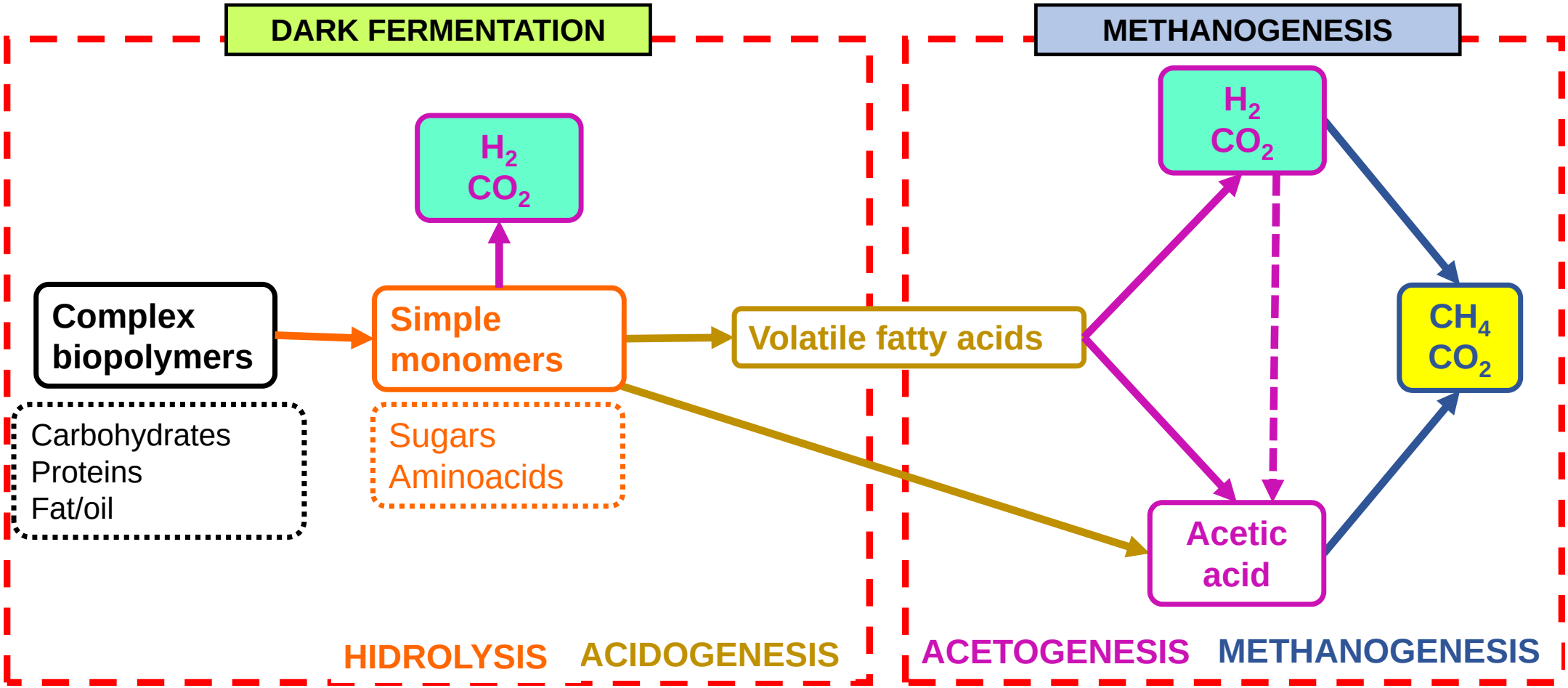
ANAEROBIC DIGESTION = BIOLOGICAL PROCESS



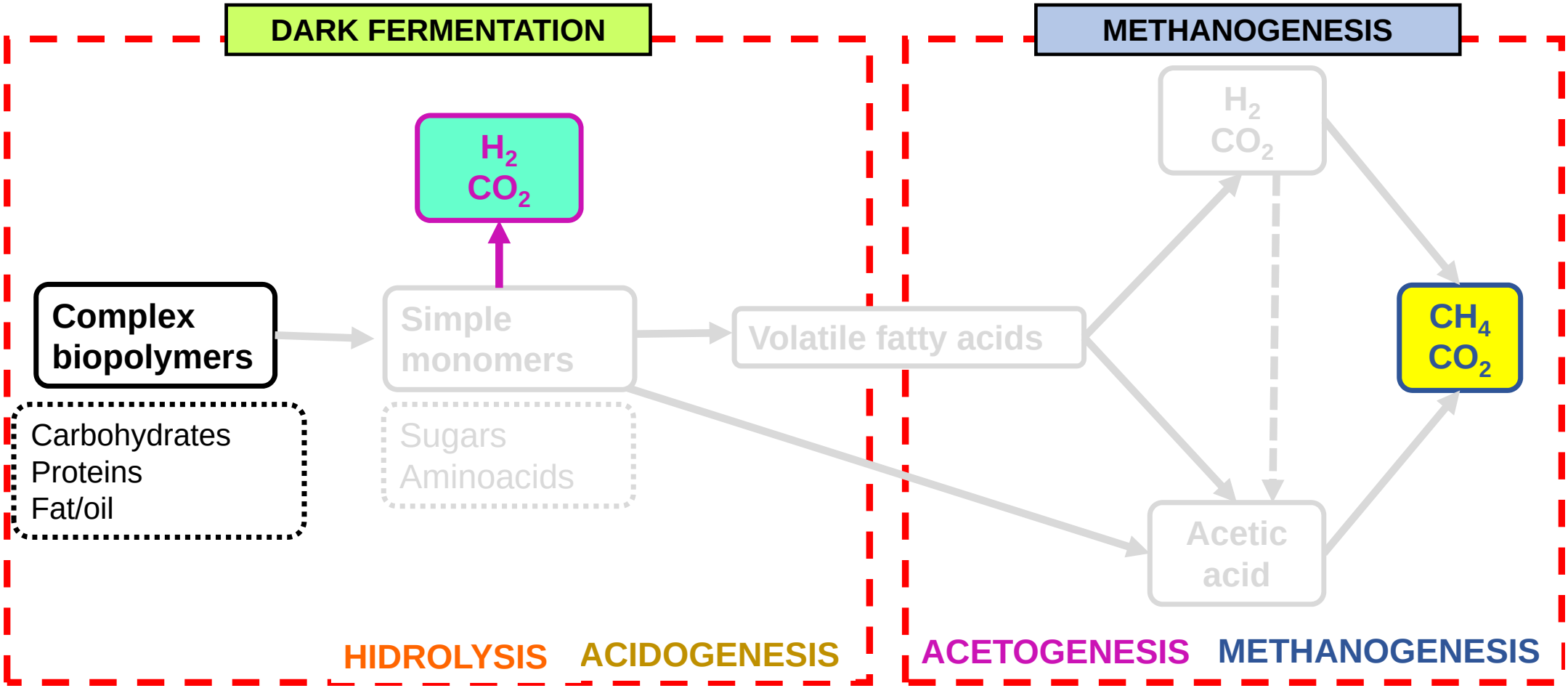
SINGLE STAGE ANAEROBIC DIGESTION PROCESS



TWO PHASED ANAEROBIC DIGESTION PROCESS



TWO PHASED ANAEROBIC DIGESTION PROCESS



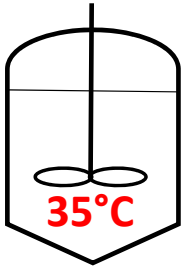
UCA Universidad de Cádiz

OBJETIVE

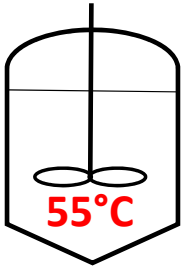
SINGLE STAGE VS TWO-PHASED ANAEROBIC DIGESTION OF SUGAR BEET BY-PRODUCTS

Experimental design

Run I
Single stage



HRT = 20 days
OLR = 3.4 ± 0.2 (gVS/Lr*d)



Run II
TPAD

Acidogenic

HRT = 10 days
OLR = 6.6 ± 0.4 (gVS/Lr*d)

Methanogenic

HRT = 20 days
OLR = 2.5 ± 0.2 (gVS/Lr*d)

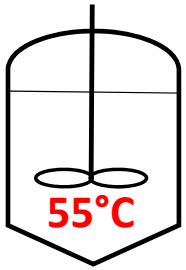
Experimental design

Run I
Single stage

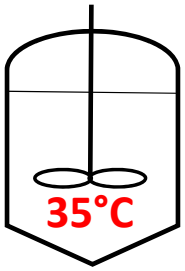
HRT = 20 days
OLR = 3.4 ± 0.2 (gVS/Lr*d)

Run II
TPAD

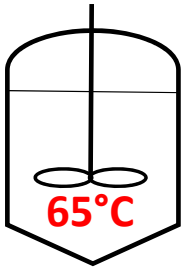
Acidogenic | **Methanogenic**

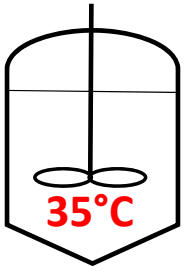


HRT = 10 days
OLR = 6.6 ± 0.4 (gVS/Lr*d)



HRT = 20 days
OLR = 2.5 ± 0.2 (gVS/Lr*d)





UCA Universidad de Cádiz

Semi-continuous stirred tank digesters

Biogas collection

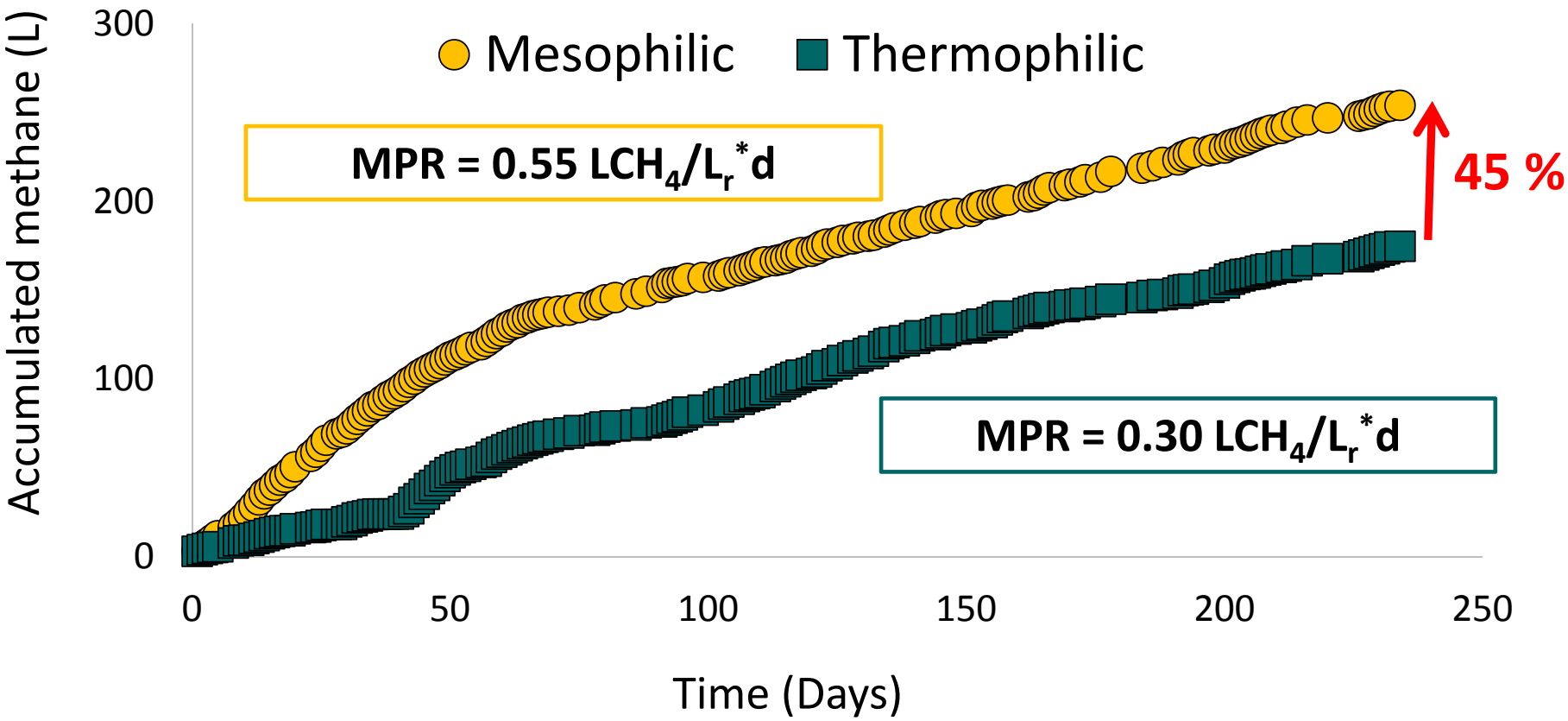
Mixing system

Temperature monitoring

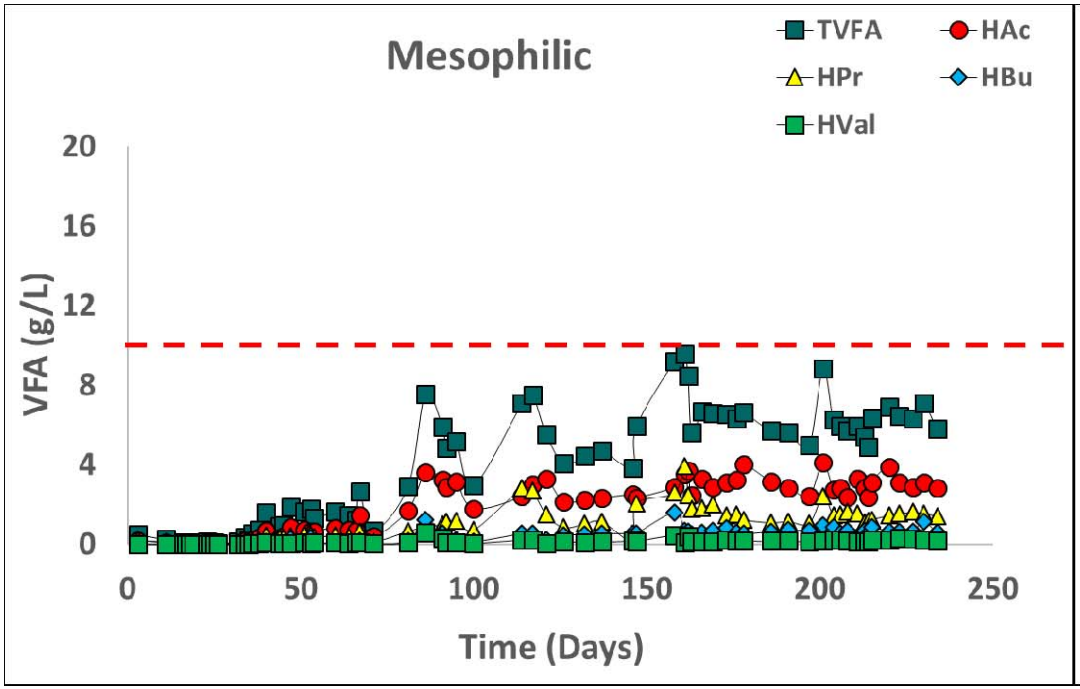
Feeding/Effluent

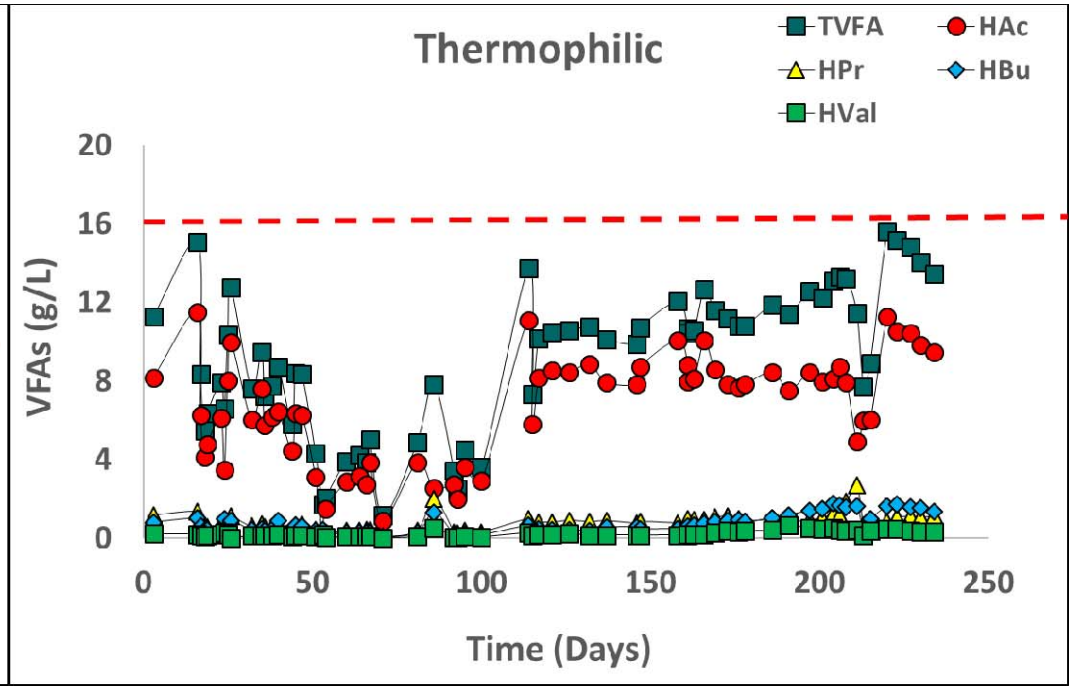
Heater plate

Single stage anaerobic digestion assays



Single stage anaerobic digestion assays



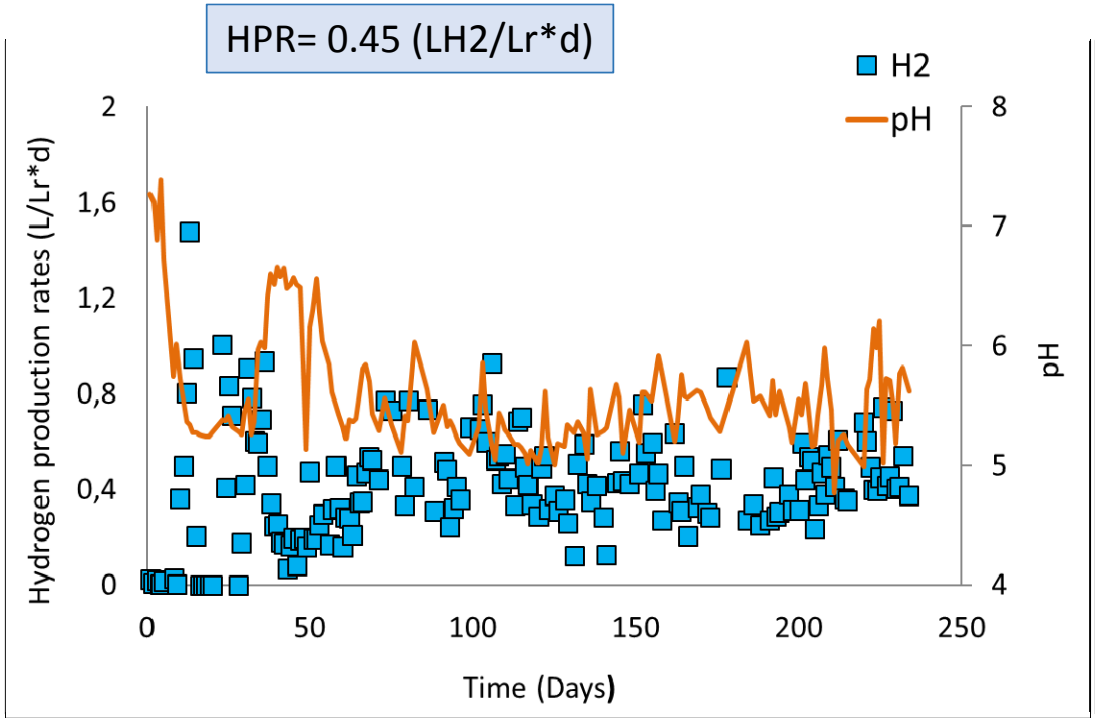


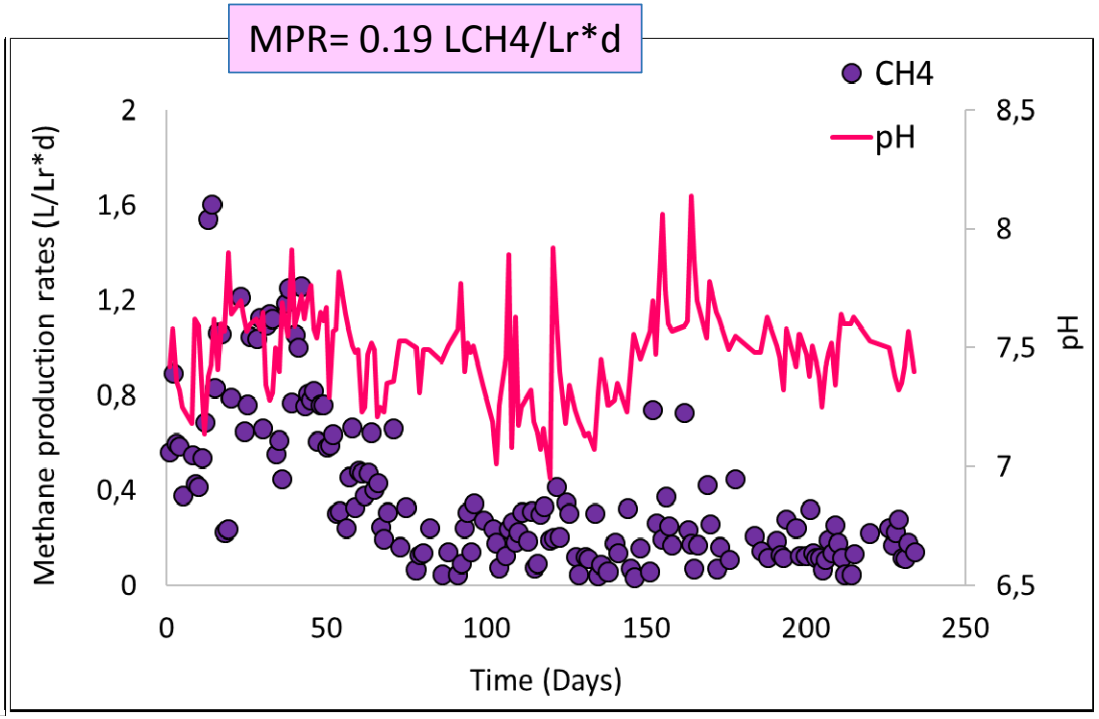
pH = 7 - 7.8
VS removal (%) = 83 %

pH = 7.5 - 8
VS removal (%) = 66%

Two-phased anaerobic digestion assays

Combination 1: Thermophilic acidogenic - mesophilic methanogenic

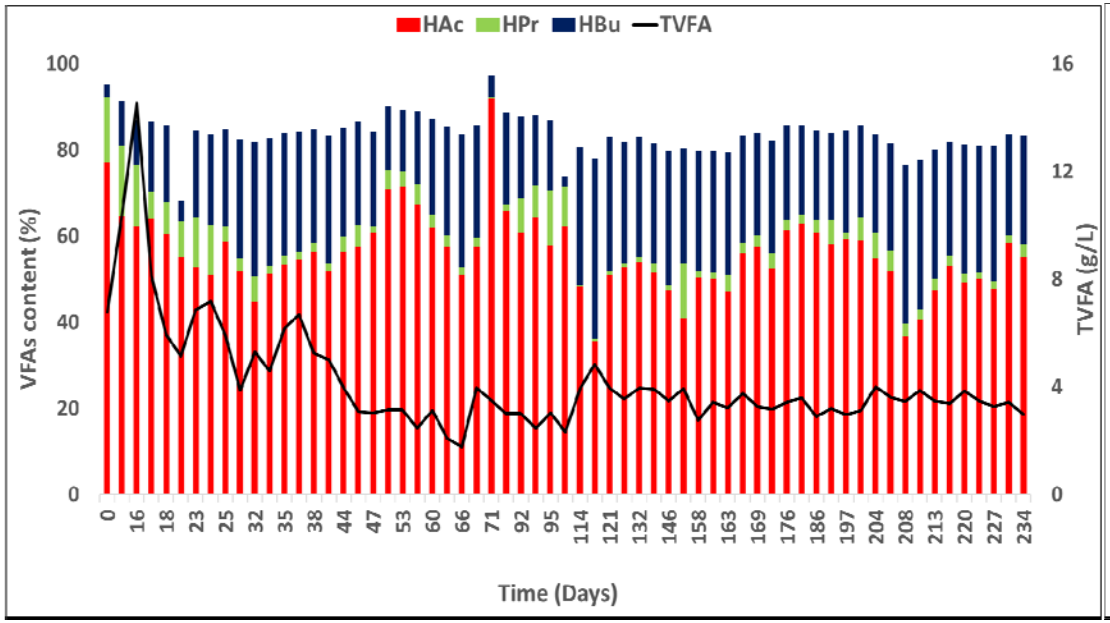




Two-phased anaerobic digestion assays

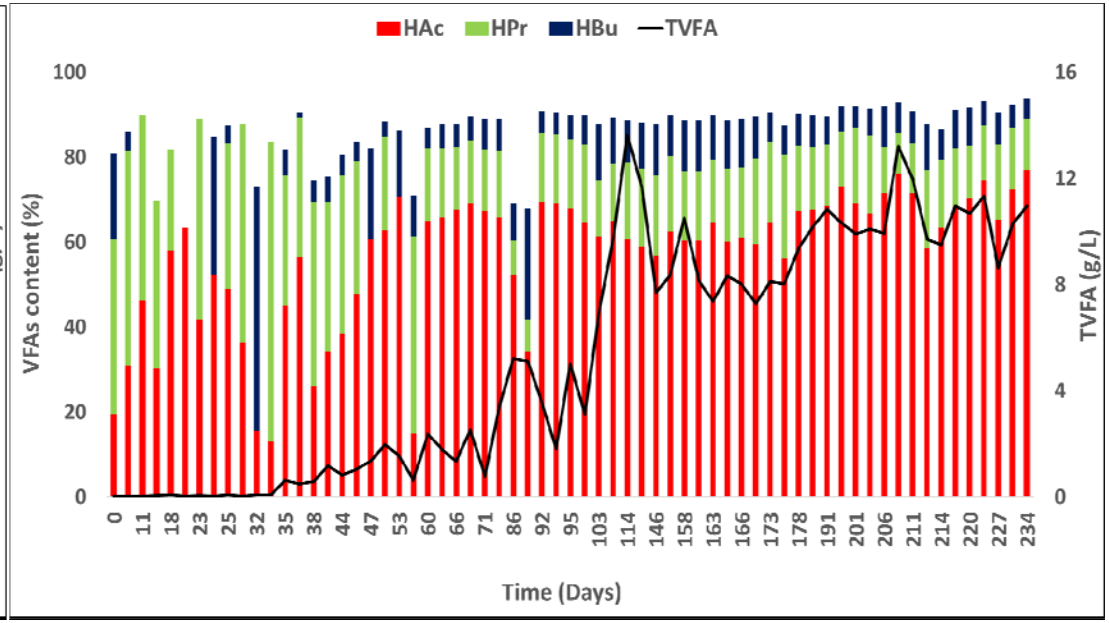
Combination 1: Thermophilic acidogenic - mesophilic methanogenic

Acidogenic digester



pH = 5.5 - 6
VS removal (%) = 46 %

Methanogenic digester

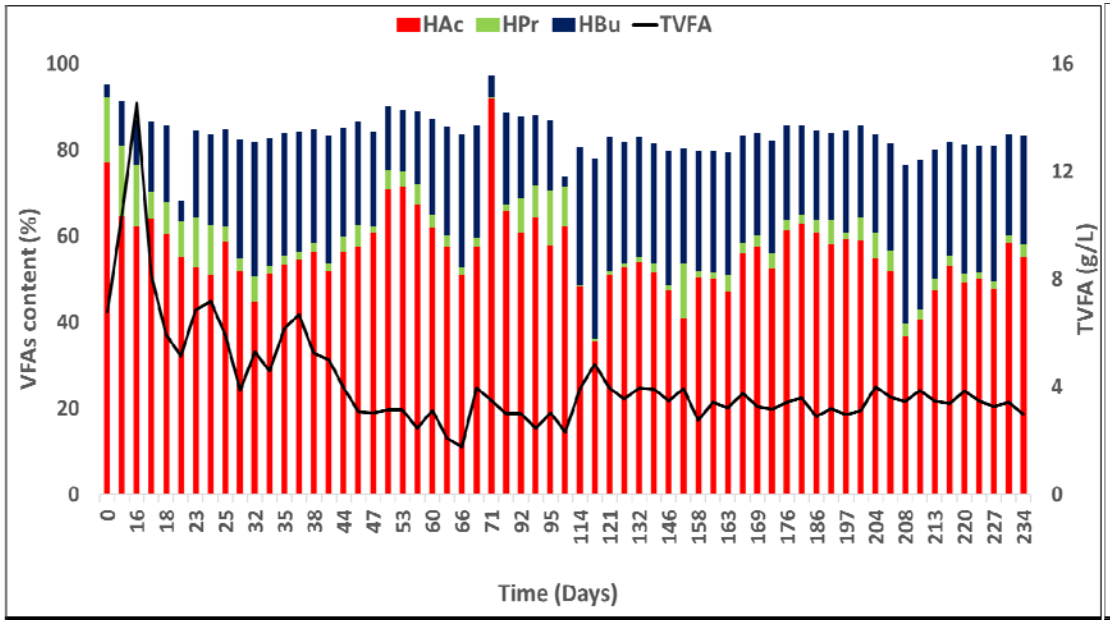


pH = 7.5 - 8
VS removal (%) = 70 %

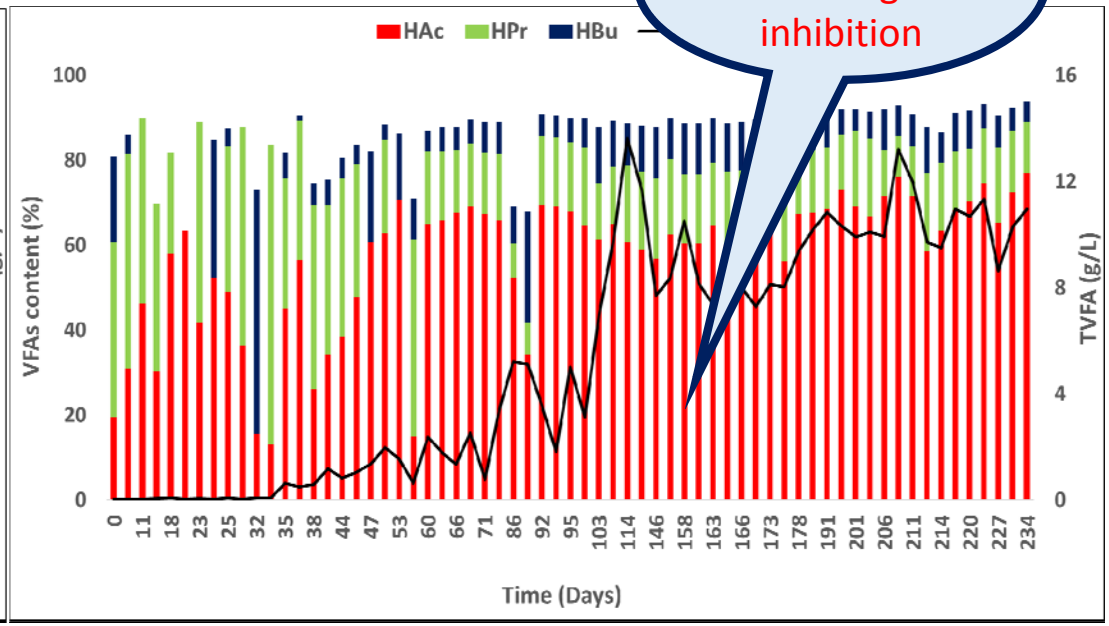
Two-phased anaerobic digestion assays

Combination 1: Thermophilic acidogenic - mesophilic methanogenic

Acidogenic digester



Methanogenic digester



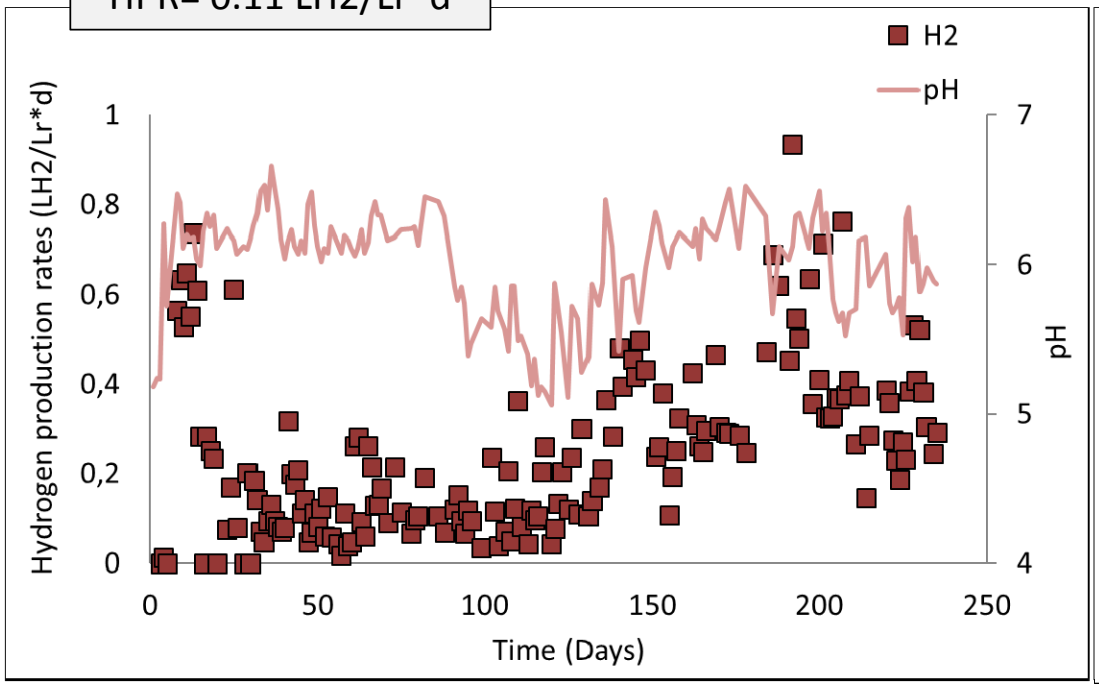
pH = 5.5 - 6
VS removal (%) = 46 %

pH = 7.5 - 8
VS removal (%) = 70 %

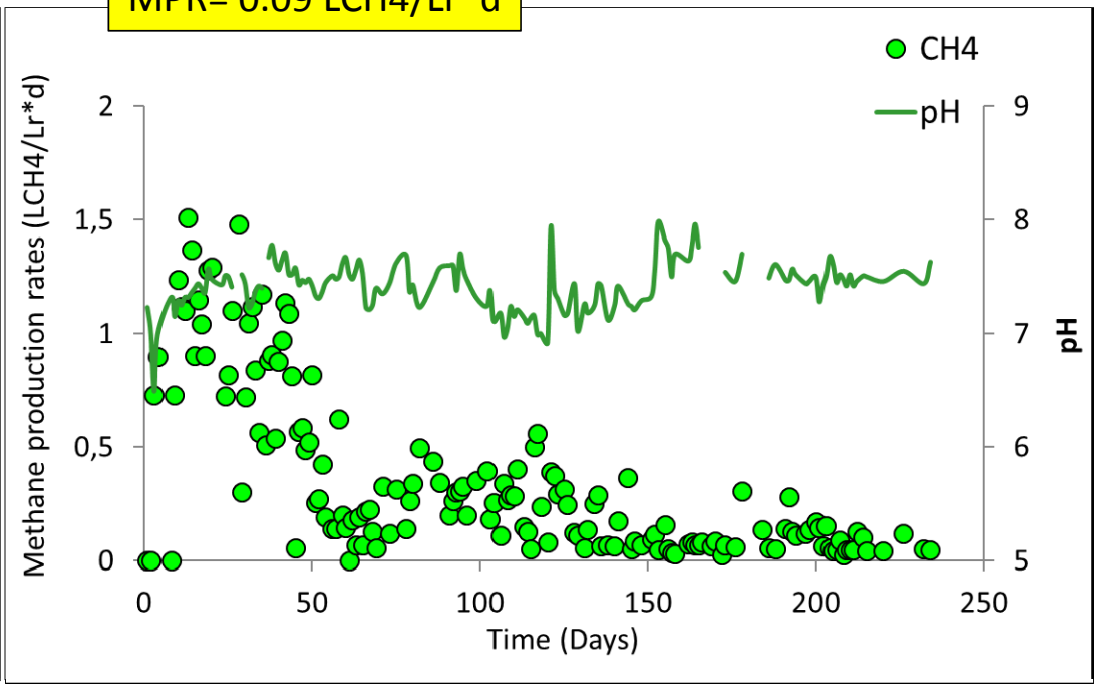
Two-phased anaerobic digestion assays

Combination 2: Hyperthermophilic acidogenic - mesophilic methanogenic

HPR= 0.11 LH2/Lr*d



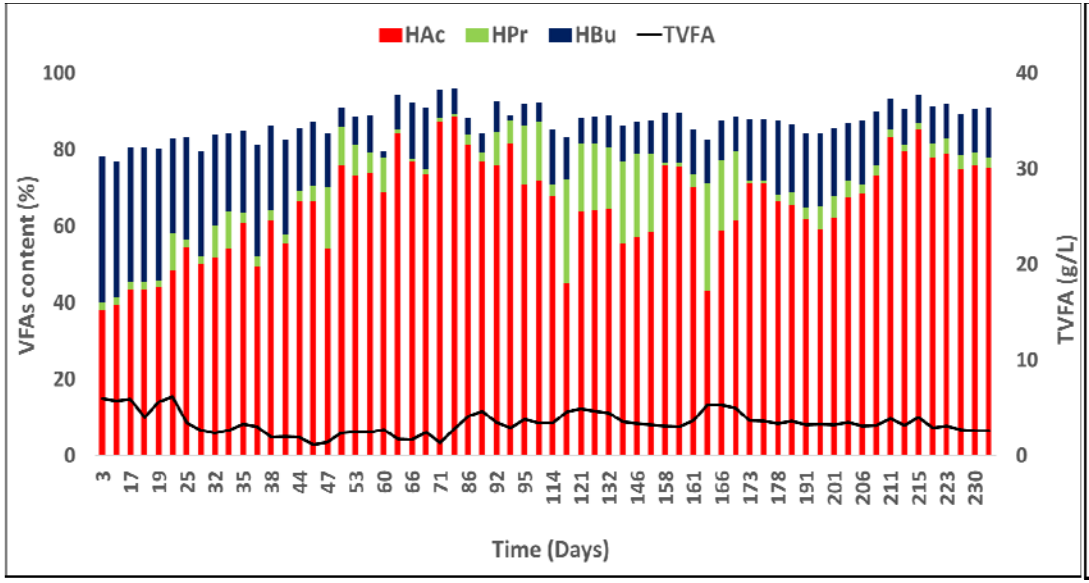
MPR= 0.09 LCH4/Lr*d



Two-phased anaerobic digestion assays

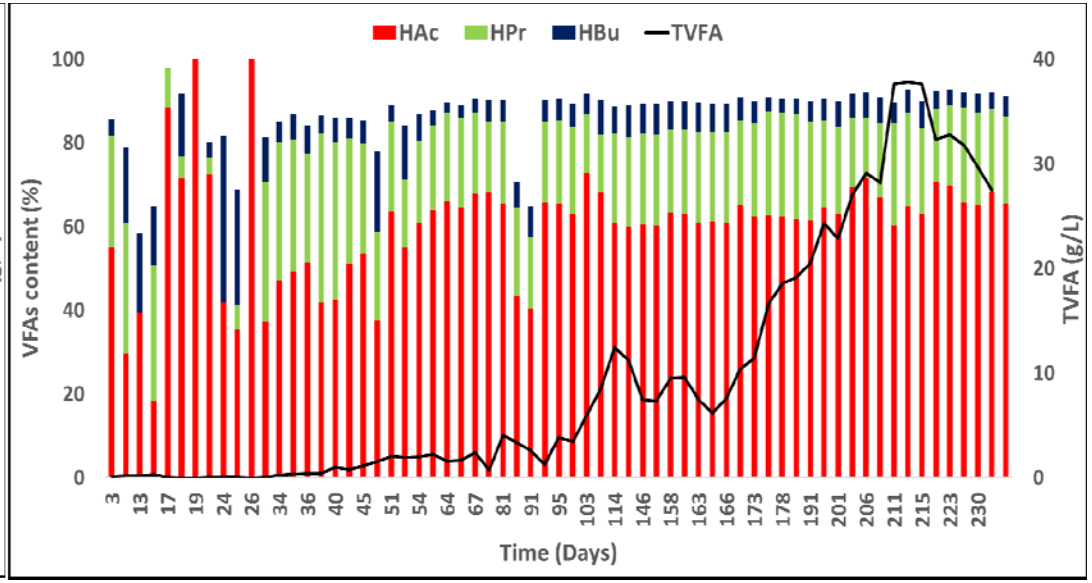
Combination 2: Hyperthermophilic acidogenic - mesophilic methanogenic

Acidogenic digester



pH = 5.5 - 6.5
VS removal (%) = 23 %

Methanogenic digester

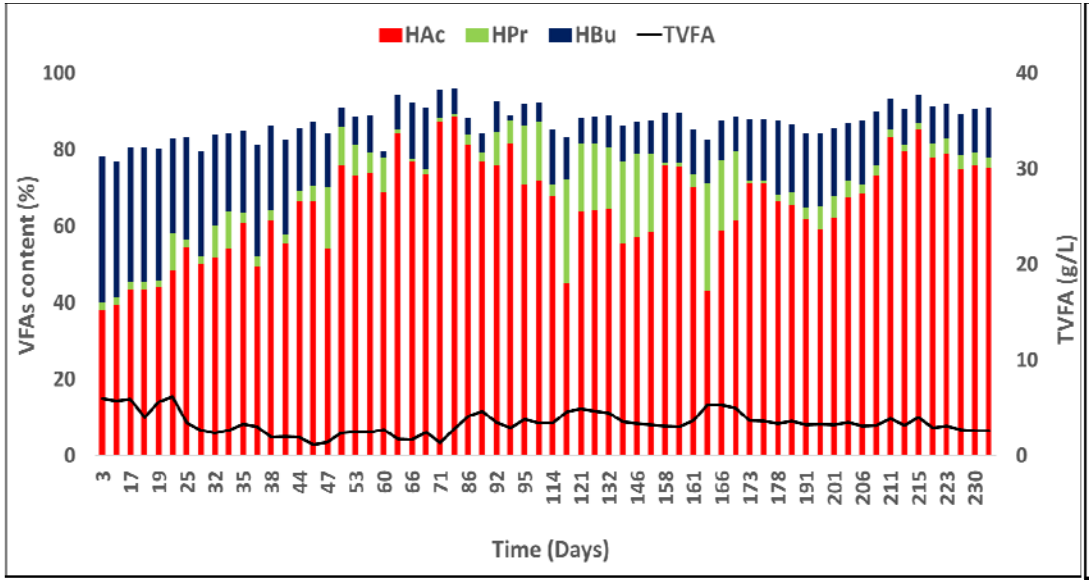


pH = 7.5 - 8.5
VS removal (%) = 72 %

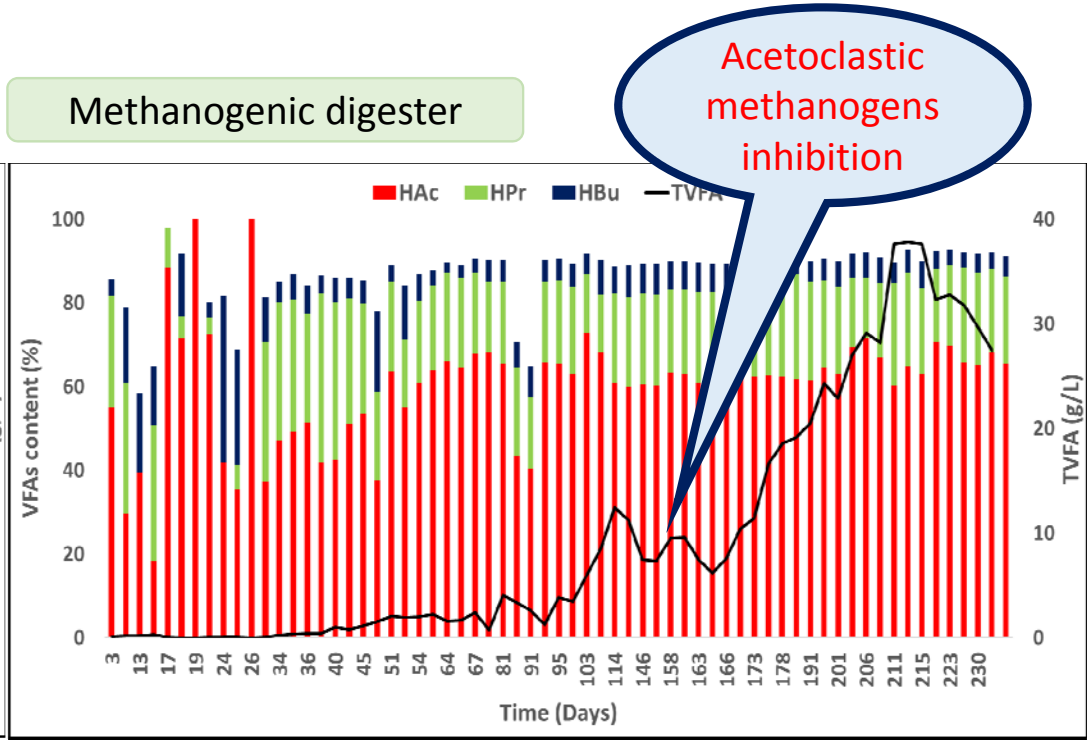
Two-phased anaerobic digestion assays

Combination 2: Hyperthermophilic acidogenic - mesophilic methanogenic

Acidogenic digester



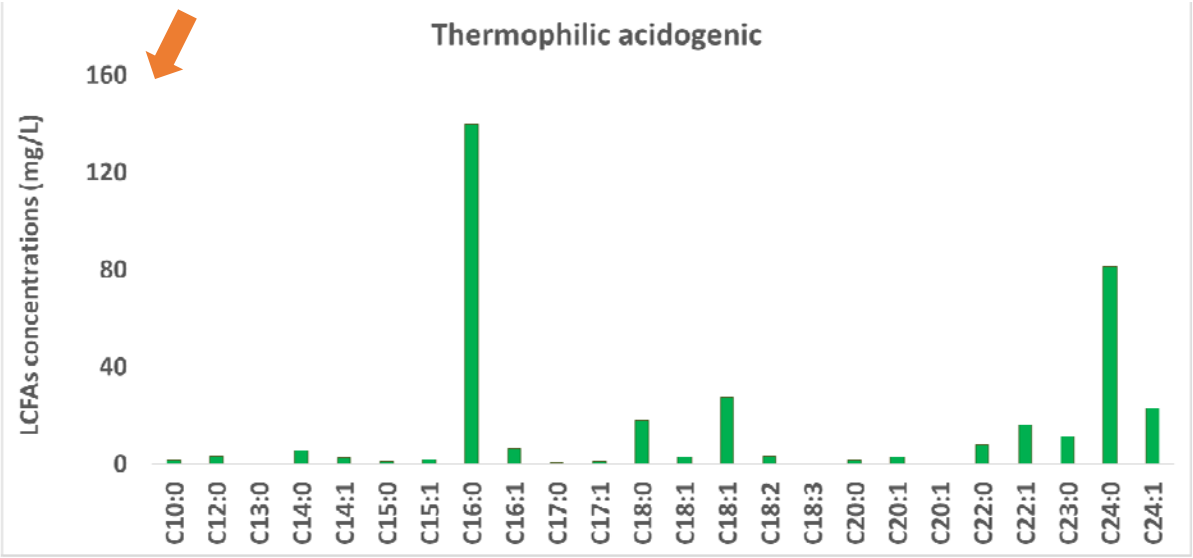
Methanogenic digester

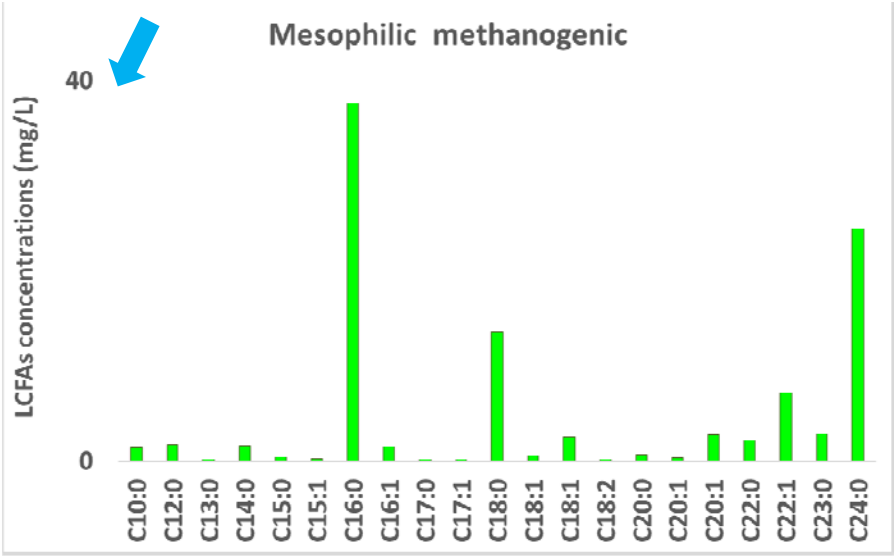


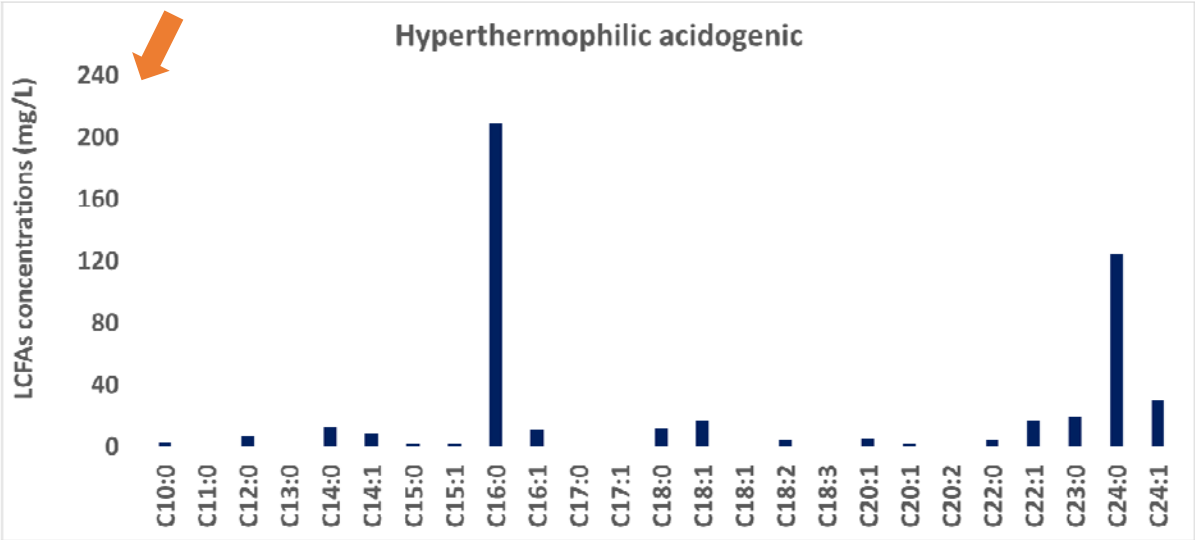
pH = 5.5 - 6.5
VS removal (%) = 23 %

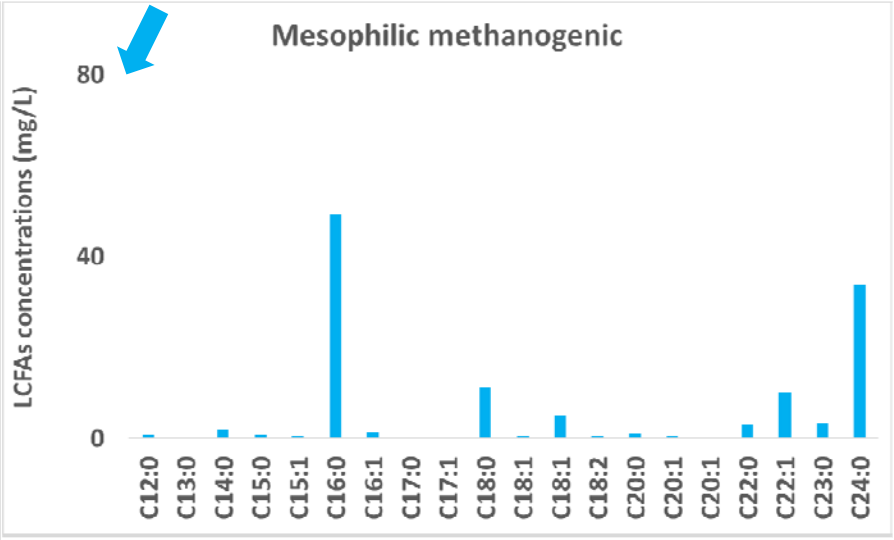
pH = 7.5 - 8.5
VS removal (%) = 72 %

Two-phased anaerobic digestion assays

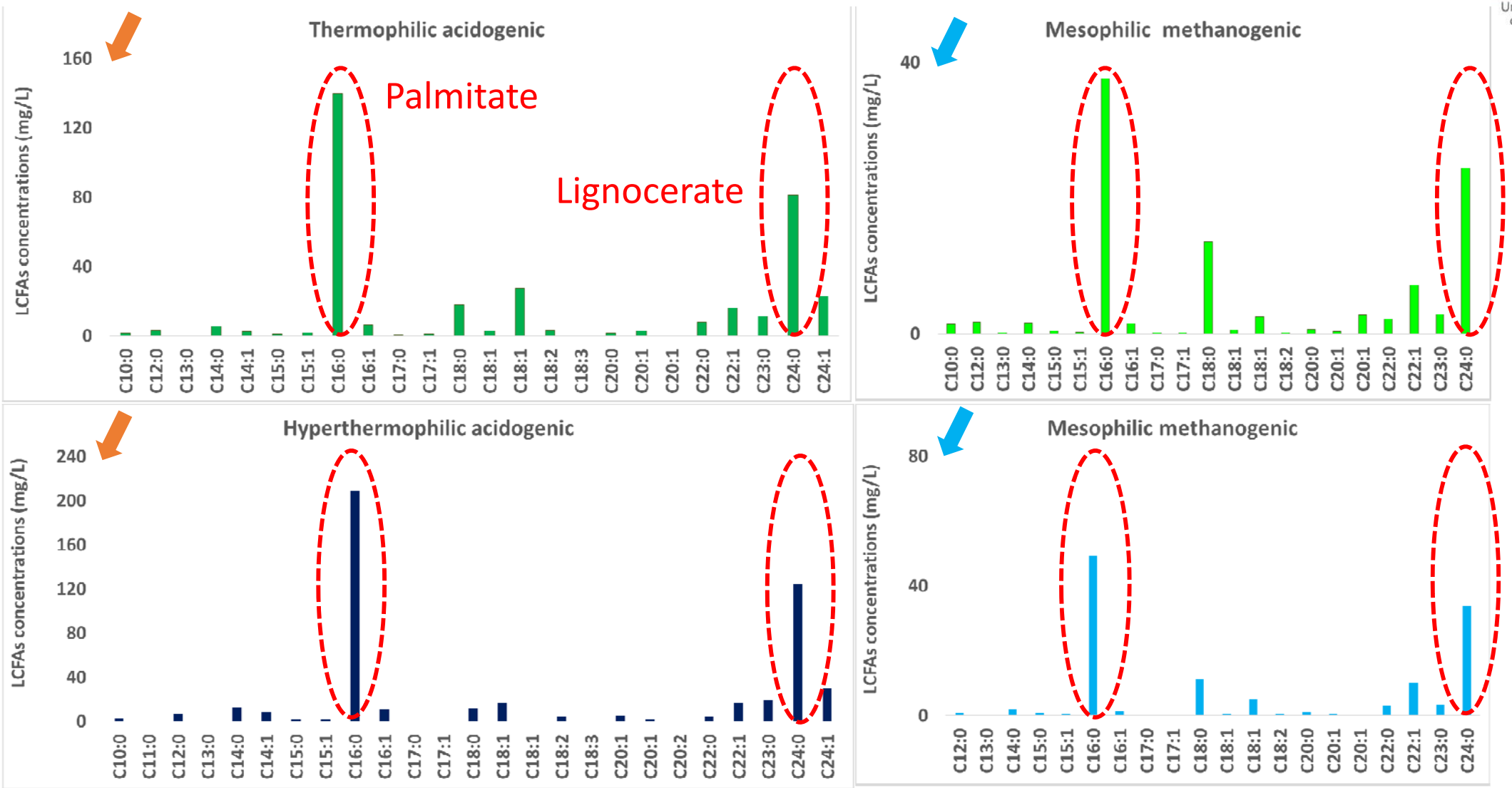








Two-phased anaerobic digestion assays



UCA Universidad de Cádiz

Is the TPAD suitable for sugar beet by-products?? ✗

Single stage ✓

Next step

Co-digestion:
Including a livestock co-substrate in the TPAD assays (pig slurry and cow manure)


Thank you for your
attention