WIRE

Waste biorefinery technologies for accelerating sustainable energy processes

Valorization of agri-based feedstock for organic acids production: biological treatment through two-phase anaerobic digestion

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WG 2

cost
EUROPEAN COOPERATION IN SCIENCE & TECHNOLOGY

Funded by the European Union

MAJOR ENVIRONMENTAL ISSUES

01 Rise in average temperatures of the planet – CO_{2eq}

02 Increasing production of wastes and effluents

SOLUTION

Development and adoption of new raw materials and technologies for energy and fuel production

Development of efficient strategies to valorise the amount of generated wastes – energy recovery with lower carbon footprint

BIOREFINERIES

use of wastes as raw materials for bio-based productions thorugh integrated technologies

Integrated biorefineries

NATIONAL ELECTRICAL GRID

ELECTRICAL ENERGY

HEAT

COGENERATION

UPGRADE

CO_2

OTHER USES

H_2

ELECTROLYSIS

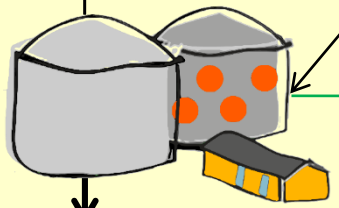
POWER-TO-METHANE
BY BIOLOGICAL METHANATION

OTHER USES

Biogas

FEEDSTOCK

ANAEROBIC DIGESTION



$Bio\text{-}CH_4$

H_2

H_2

DIGESTATE

Reforming
bio-CH_4 + CCS

LAND FERTILIZER

NATURAL GAS GRID

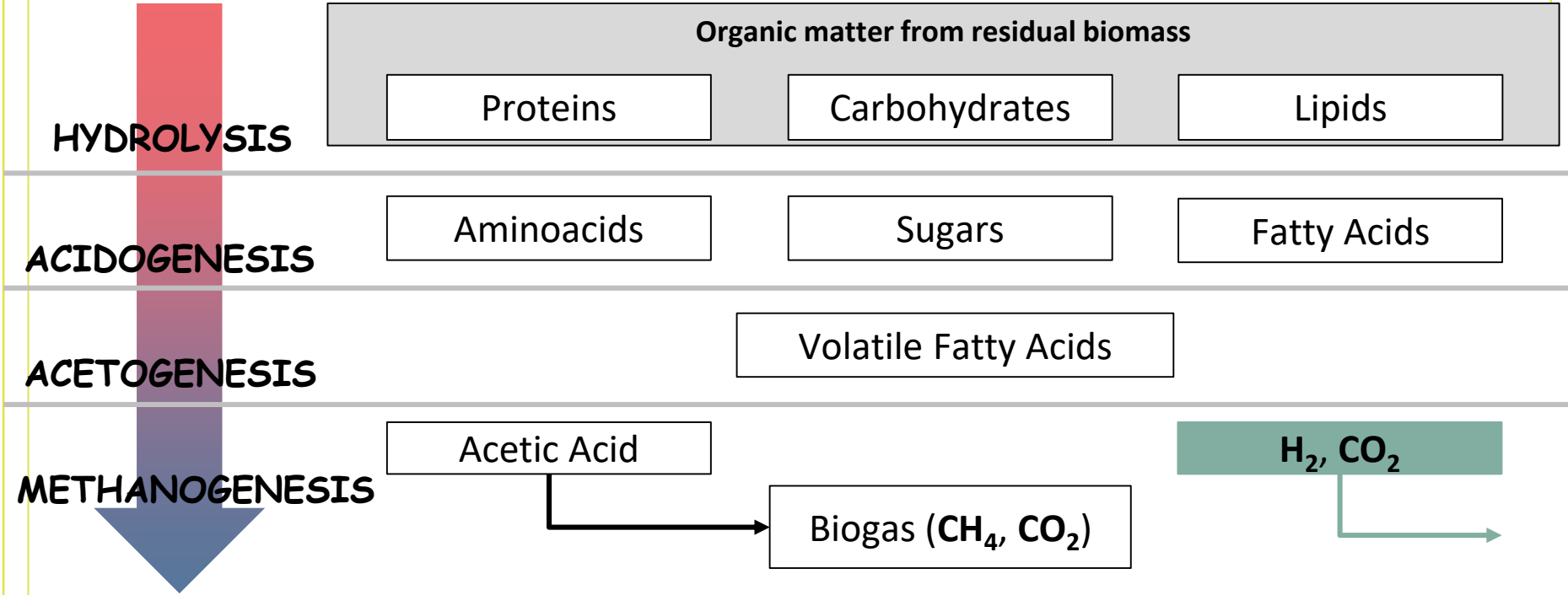
ECOSISTER

MISSION: support the ecological transition of the regional economic and social system through a process involving all sectors, technologies and skills combining digital transition and sustainability with the work and well-being of people and the protection of the environment

SPOKE 5 - Circular economy and blue economy

WP2 Waste and wastewater arising from production and domestic consumption chains: valorization and transformation of waste into new materials/products. Prevention, reuse, recycling, re-design of materials and decommissioning

Dark Fermentation



Introduction: 2-phase Anaerobic Digestion

Agricultural biogas plant configuration suitable for 2-phase AD

- AD process separated into two steps :
  (1) hydrolysis and acidification
  (2) conversion of acetate, H_2 and CO_2 into CH_4
- Different operational conditions such as OLR, pH, and HRT are required in the two phases
- The concept of 2-phase AD is to optimize the growth conditions for different groups of microorganisms bringing to better process performances

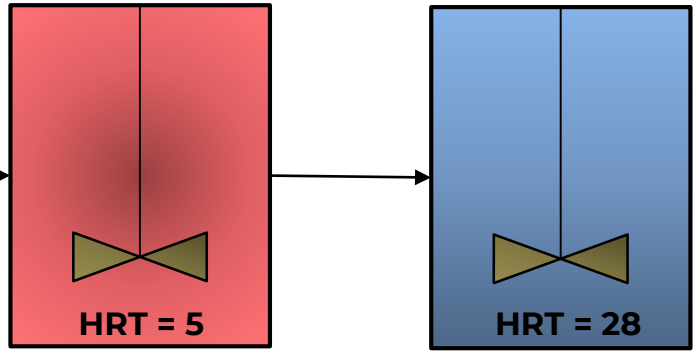
Experimental plan

TWO-PHASE AD

R1 - ACIDOGENIC REACTOR

R2 - METHANOGENIC REACTOR

Barley residues 12%
Ryegrass silage 7%
Olive pomace 3%
Milling by-products 2%
Poultry manure 5%



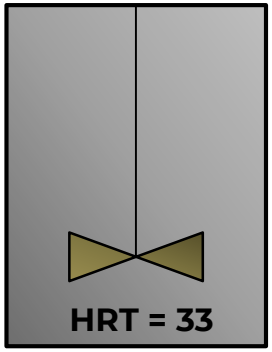
COV=23,7 gVS/L day

COV=2,4 gVS/L day

Pig slurry 71%

SINGLE PHASE AD

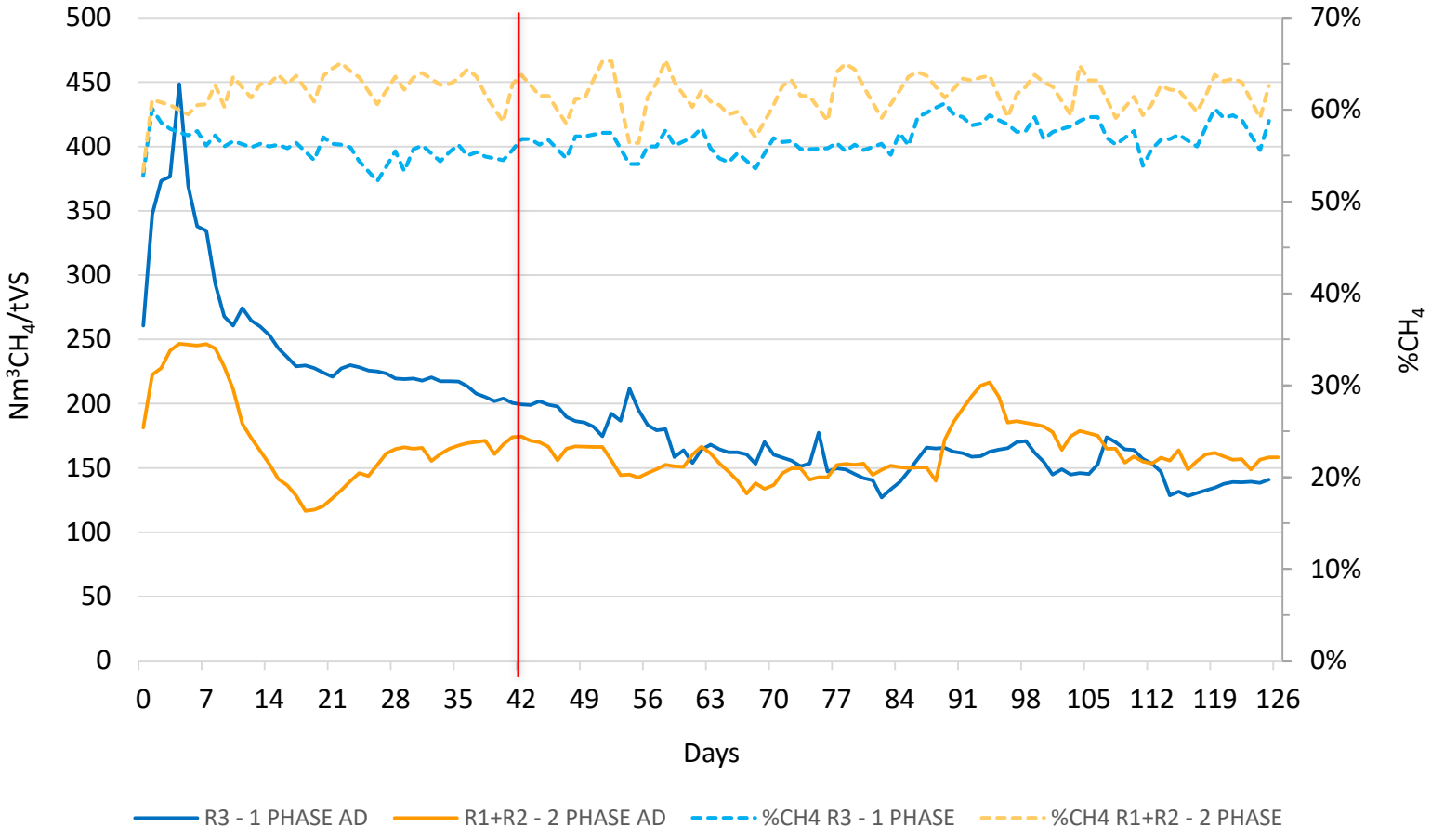
R3 -CONTROL REACTOR



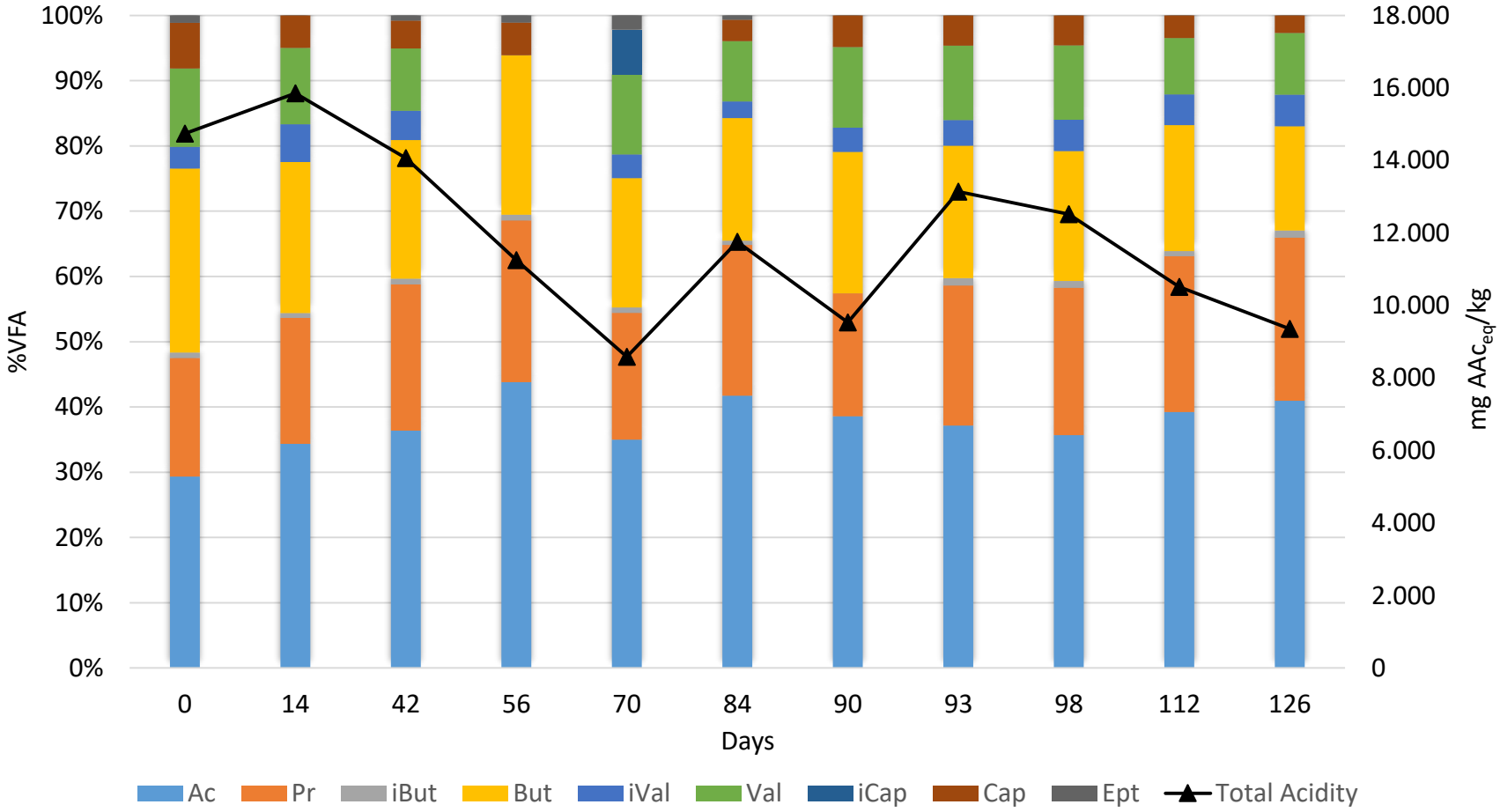
COV=3,4 gVS/L day

Barley residues 12%
Ryegrass silage 7%
Olive pomace 3%
Milling by-products 2%
Poultry manure 5%
Pig slurry 71%

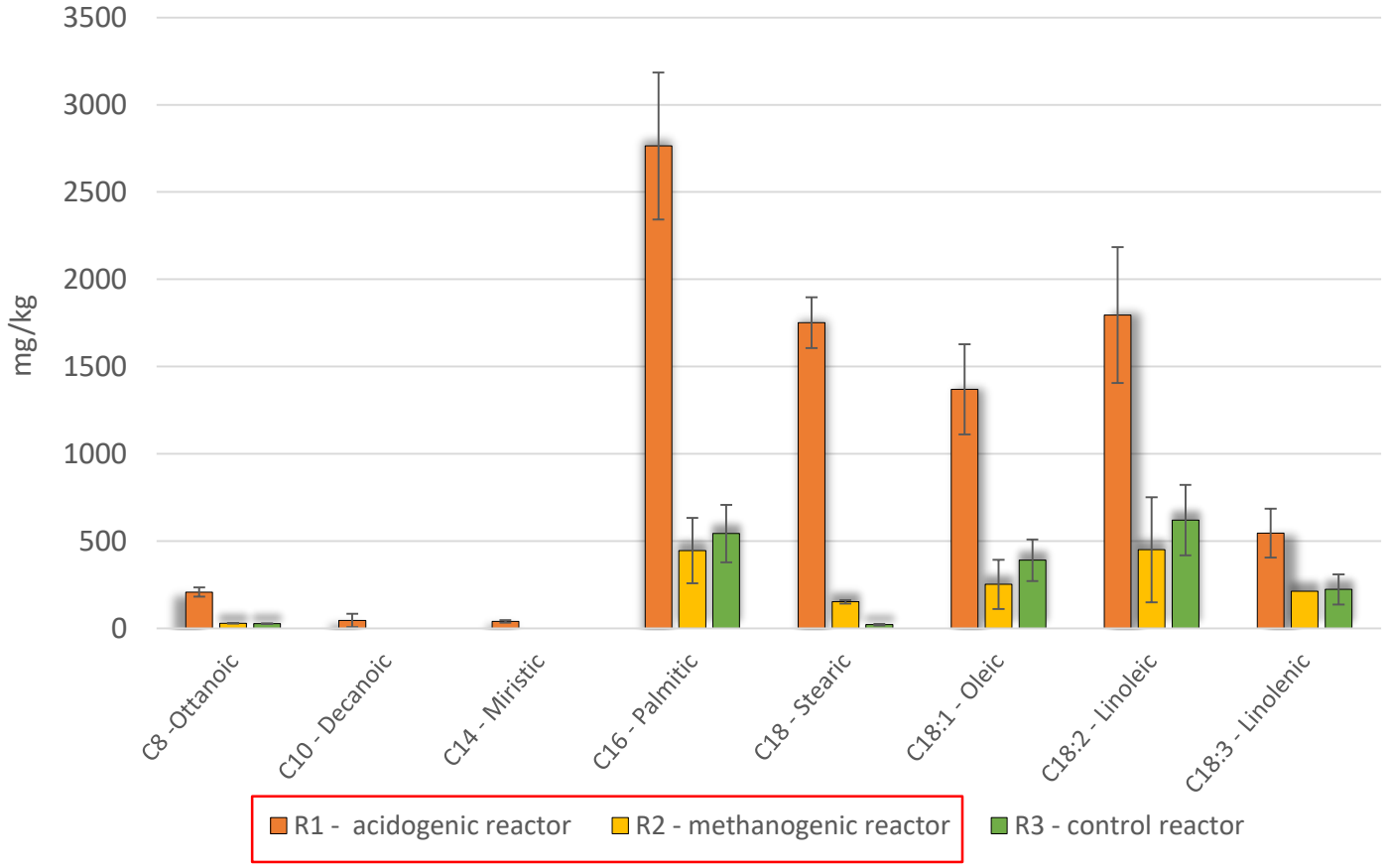
Specific methane production



VFA – Volatile Fatty Acids in R1



LCFA – Long Chain Fatty Acids



Conclusions

- In this study, AD of agroindustrial byproducts + animal manure in mesophilic conditions, once at regime, does not show any difference in specific methane production comparing single phase and two-phase AD process (161 Nm^3CH_4/tSV)

- VFA (C2-C7) concentration in the acidogenic reactor, a the end of the test, reached ~10 g/kg, mainly acetic (40%), propionic (25%), butyric (15%) and valeric (10%) acids

- LCFA (C16-C20) concentration in the acidogenic reactor, at the end of the test, reached ~8,5 g/kg, mainly palmitic (32%), stearic (21%), linoleic (21%) and oleic (16%) acids

- Two-phase and single-phase AD showed the same energy production efficiency; by the way, two-phase process allows flexibility in addressing the production towards bioeconomy (VFA, LCFA extraction) or bioenergy production (biomethane)

Future investigations

01

Microbial community analysis in two-phases AD – taxonomic analysis + digital PCR tests on LCFA-specific markers.

02

Residual biogas potential test for process efficiency evaluation – calculation of the residual methane still producible by the outcoming digestate from the two-phase and the single-phase processes

Thank you!

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WG2: Biorefinery Technologies

WIRE Working Groups Workshop (Cottbus 4-5th October)

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