HERAKLION 2019
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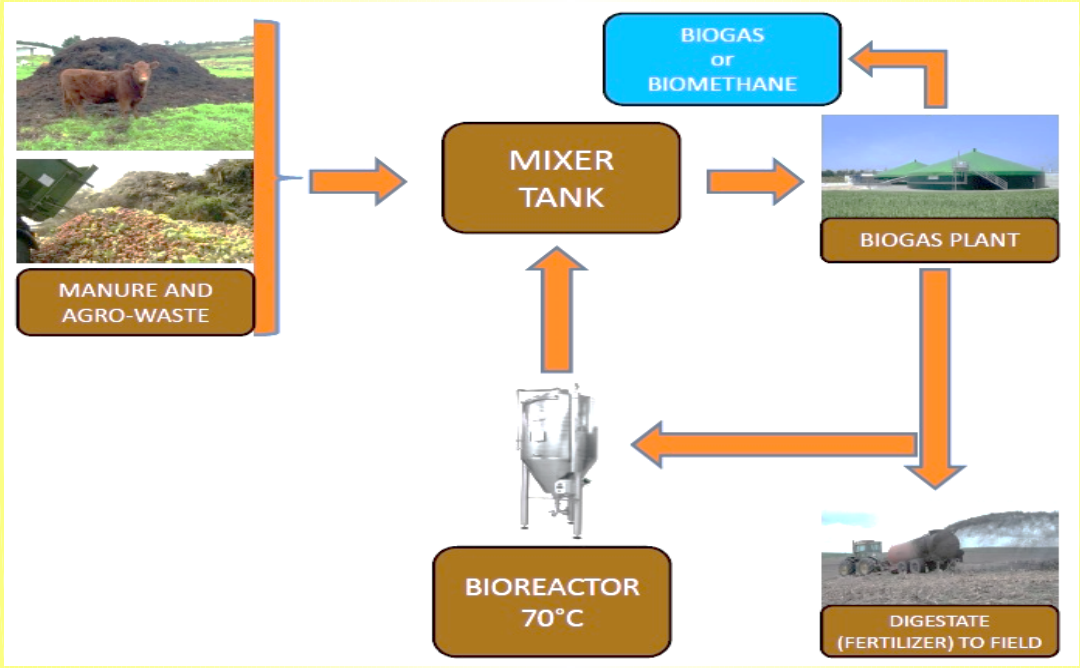


# BIOLOGICAL POST HYDROLYSIS OF DIGESTATE ENHANCES THE BIOGAS PRODUCTION IN ANAEROBIC DIGESTION OF AGRO-WASTE

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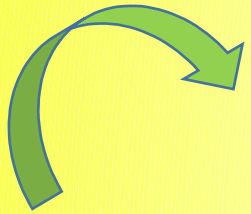
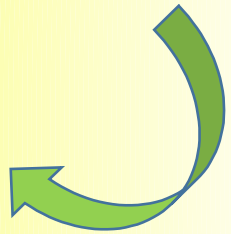


## INTRODUCTION

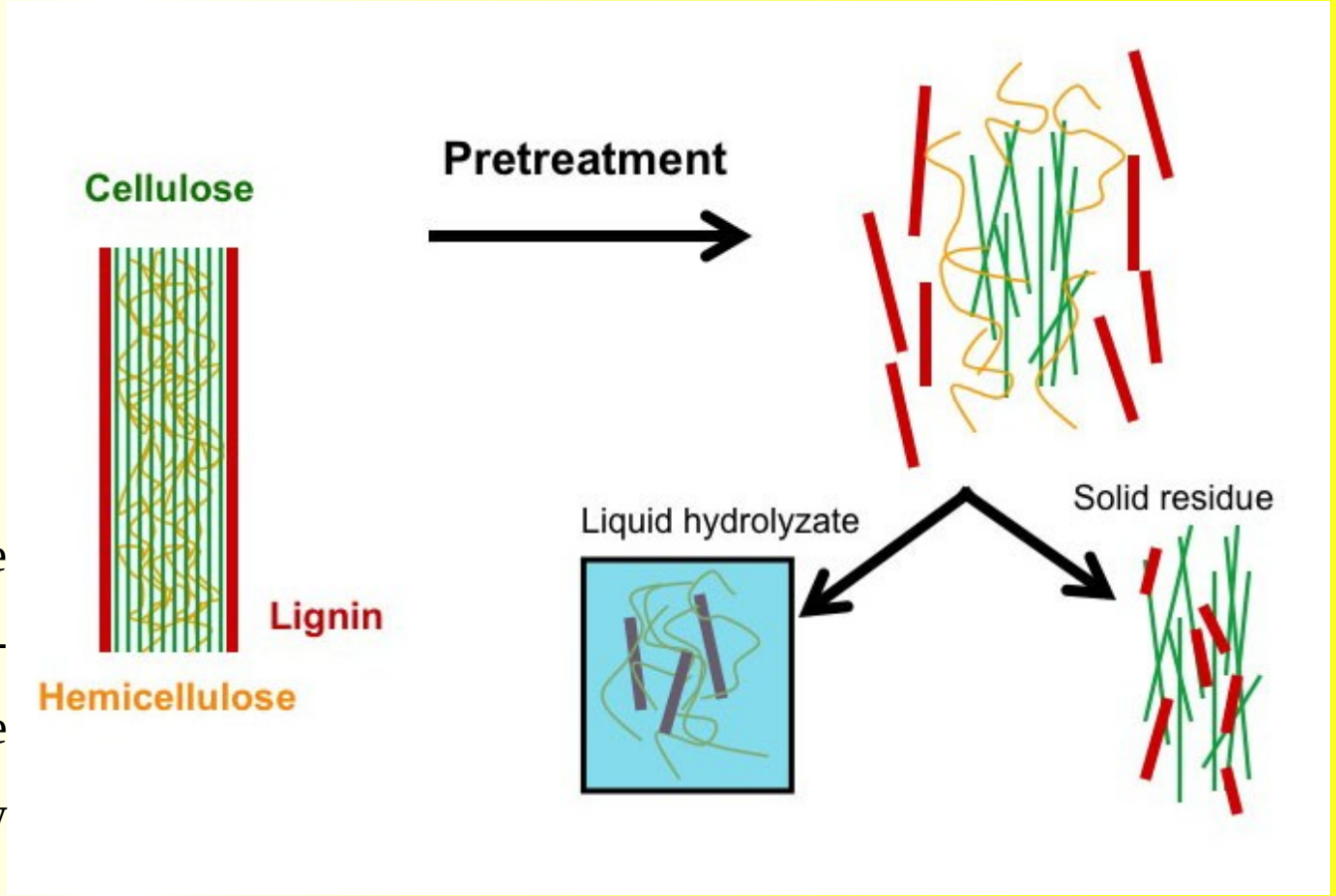
Organic residual from farm and agricultural activities are among the most abundant wastes in Europe with more than 1,500 million tons/year and 250 million tons/year, respectively. Circular economy model encouraged the exploitation of these wastes streams close to farms where they are produced to reduce the energetic and economic costs for transport. ***Anaerobic digestion (AD) is the most adopted technology for the management of great amount of agricultural wastes.***

Only the 40% - 50% of the feed stock will be converted to biogas.

**NEED OF PRETREATMENTS**

**THIS WORK**
**MILD POST-THERMAL TREATMENTS**

This research simulated a 70°C thermal treatment to the recirculated fraction of digestate, derived from a full-scale digester, treating manure and straw. After the thermal post-treatment, the digestate is mixed with new fresh organic matter for a mesophilic AD process.



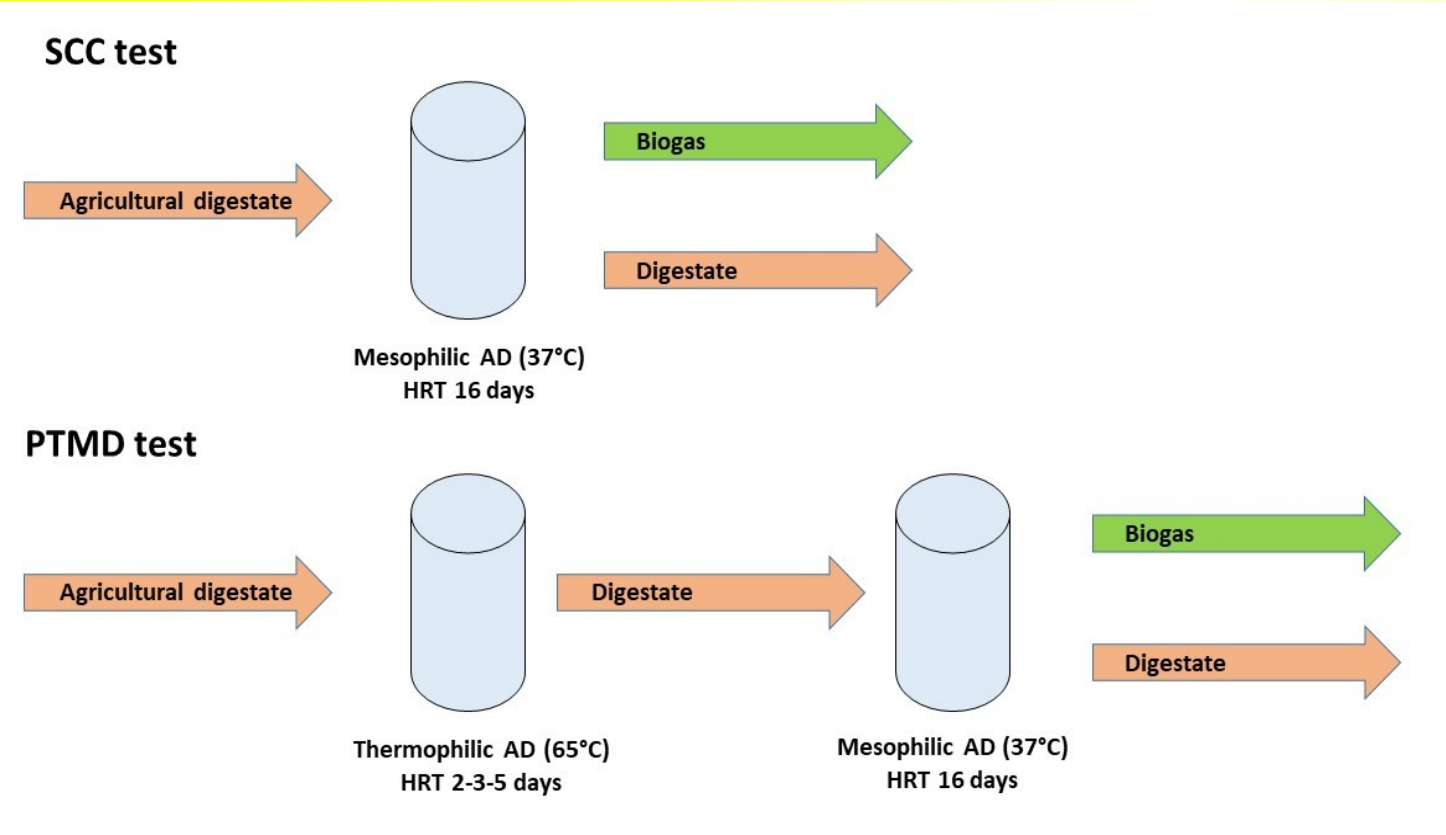
## BMP TESTS

BMP tests have been conducted to determine the methane production:

- An agricultural mesophilic digestate from a full scale reactor located at Isola della Scala (Italy) working at 37°C
- An agricultural thermophilic digestate from a full scale reactor located at Treviso working at 65°C.


$$P_{net}(t) = P_{max} \exp\{-\exp[\frac{R_{max} * e}{P_{max}}(\lambda - t) + 1]\}$$

## SEMI-CONTINOUS TESTS




The performances of the PTMD were evaluated in semi-continuous mode too and compared with a semi-continuous control test (SCC). Figure 2 summarizes the SCC and PTMD processes. In the PTMD test the mesophilic digestate was digested at 70°C and then digested for a second time at mesophilic temperature (37°C). On the contrary SCC was simply digested a second time at 37°C.

## SEMI-CONTINOUS TESTS

| | OLR of the different phase of PTDM test (kg TVS / m³ d) | | |
|---|---|---|---|
| **Reactor** | HRT (2 days) | HRT (3 days) | HRT (5 days) |
| **SCC process** | 3.64 ± 0.24 | 3.25 ± 0.30 | 3.54 ± 0.11 |
| **Thermophilic reactor of PTDM** | 24.78 ± 0.84 | 17.33 ± 1.60 | 11.34 ± 0.34 |
| **Mesophilic reactor of PTDM** | 3.49 ± 0.28 | 3.20 ± 0.18 | 3.18 ± 0.14 |

The performances of the semi-continuous tests were evaluated considering the difference of: i) the methane productions between SCC test and the mesophilic reactor of PTMD tests; ii) soluble Chemical Oxygen Demand (sCOD) and Volatile Fatty Acids concentrations between SCC and PTMD tests. These latter parameters are considered as indicators of the hydrolysis efficacy of the thermal treatment.

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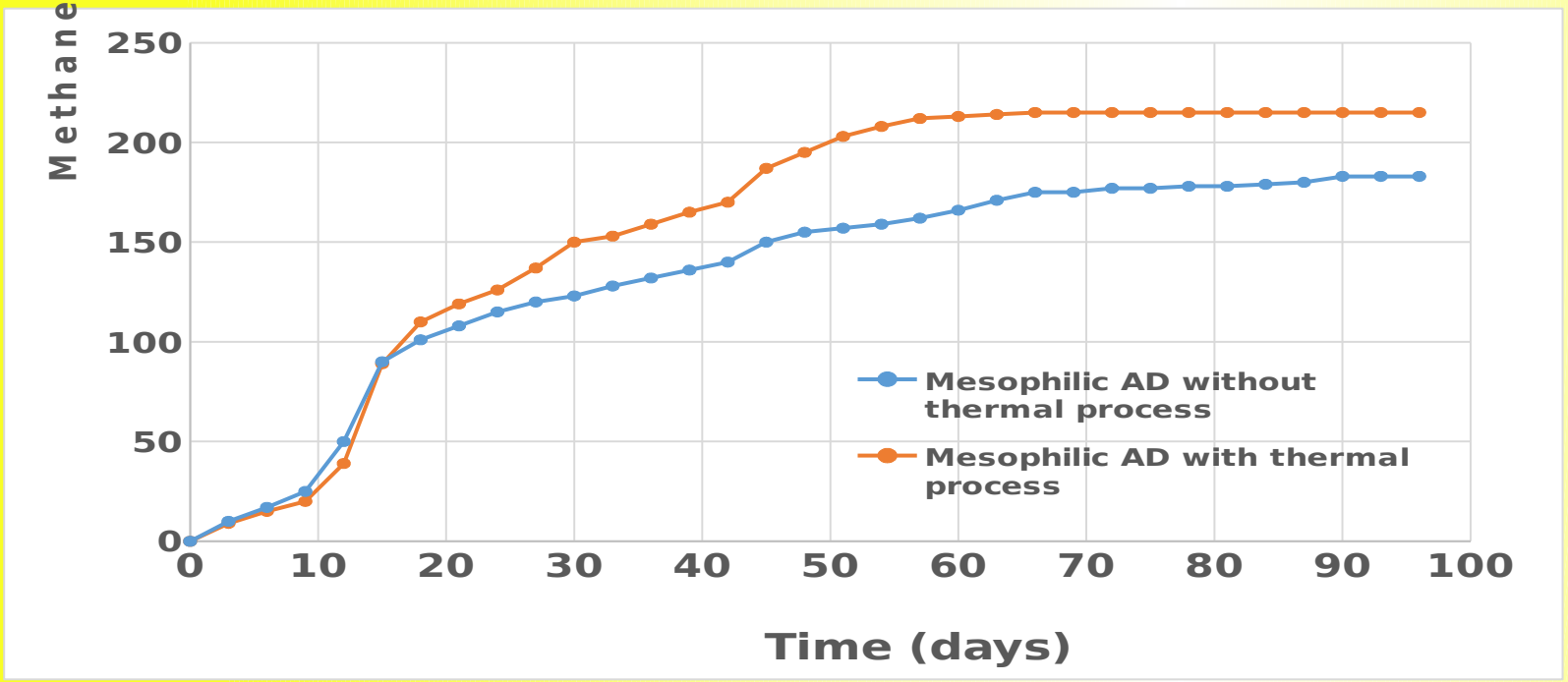
## BMP TESTS




The trend of the BMP tests, having similar exponential growth in the first 15 days, demonstrate that thermal treatment seems to be efficacy on the degradation of more recalcitrant and slowly degradable organic compounds. The kinetic of residual simple compounds (sugars and carbohydrates) was not affected by thermal treatment. Instead, it improved the solubilization of more complex molecules, such as lipids and proteins, present in high concentration in digestate from manure AD.

## SEMI-CONTINOUS TESTS

| | | HRT 2 days | | HRT 3 days | | HRT 5 days | |
|---|---|---|---|---|---|---|---|
| | SCC | Thermophilic reactor of PTDM | Mesophilic reactor of PTDM | Thermophilic reactor of PTDM | Mesophilic reactor of PTDM | Thermophilic reactor of PTDM | Mesophilic reactor of PTDM |
| **TS (% w/w)** | 75.80 ± 2.06 | 67.54 ± 3.13 | 65.04 ± 3.05 | 62.80 ± 1.94 | 53.74 ± 1.64 | 62.62 ± 3.37 | 54.20 ± 2.52 |
| **TVS (% w/w)** | 53.20 ± 2.51 | 46.40 ± 2,58 | 44.62 ± 2.37 | 42,02 ± 1.93 | 35.17 ± 2.96 | 40.24 ± 2.25 | 36.59 ± 1.52 |
| **pH** | 8.08 ± 0.13 | 8.46 ± 0.15 | 8.23 ± 0.10 | 8.34 ± 0.08 | 8.20 ± 0.05 | 8.45 ± 0.15 | 8.22 ± 0.17 |
| **COD (mg O2/gTS)** | 790.91 ± 29.34 | 847.84 ± 29.91 | 843.54 ± 30.36 | 850.38 ± 33.91 | 803.51 ± 28.40 | 795.85 ± 27.34 | 772.20 ± 44.70 |
| **sCOD (g O2/L)** | 6.53 ± 1.05 | 7.83 ± 2.27 | 7.21 ± 1.98 | 8.67 ± 0.78 | 7.51 ± 0.26 | 8.75 ± 0.68 | 7.39 ± 0.81 |
| **VFA (mg O2/L)** | 129.02 ± 30.92 | 1500 ± 50 | 409.05 ± 5.52 | 1888 ± 270 | 196.07 ± 31.20 | 1890 ± 160 | 129.20 ± 30.57 |
| **P (mg/gTS)** | 13.50 ± 1.10 | 13.20 ± 0.91 | 13.00 ± 0.43 | 13.66 ± 1.57 | 13.71 ± 0.89 | 13.68 ± 0.55 | 13.72 ± 0.08 |
| **TKN (mg/gTS)** | 18.04 ± 3.47 | 19.90 ± 1.20 | 23.98 ± 4.05 | 19.73 ± 2.11 | 19.38 ± 1.07 | 20.36 ± 3.20 | 20.06 ± 2.14 |

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## SEMI-CONTINOUS TESTS

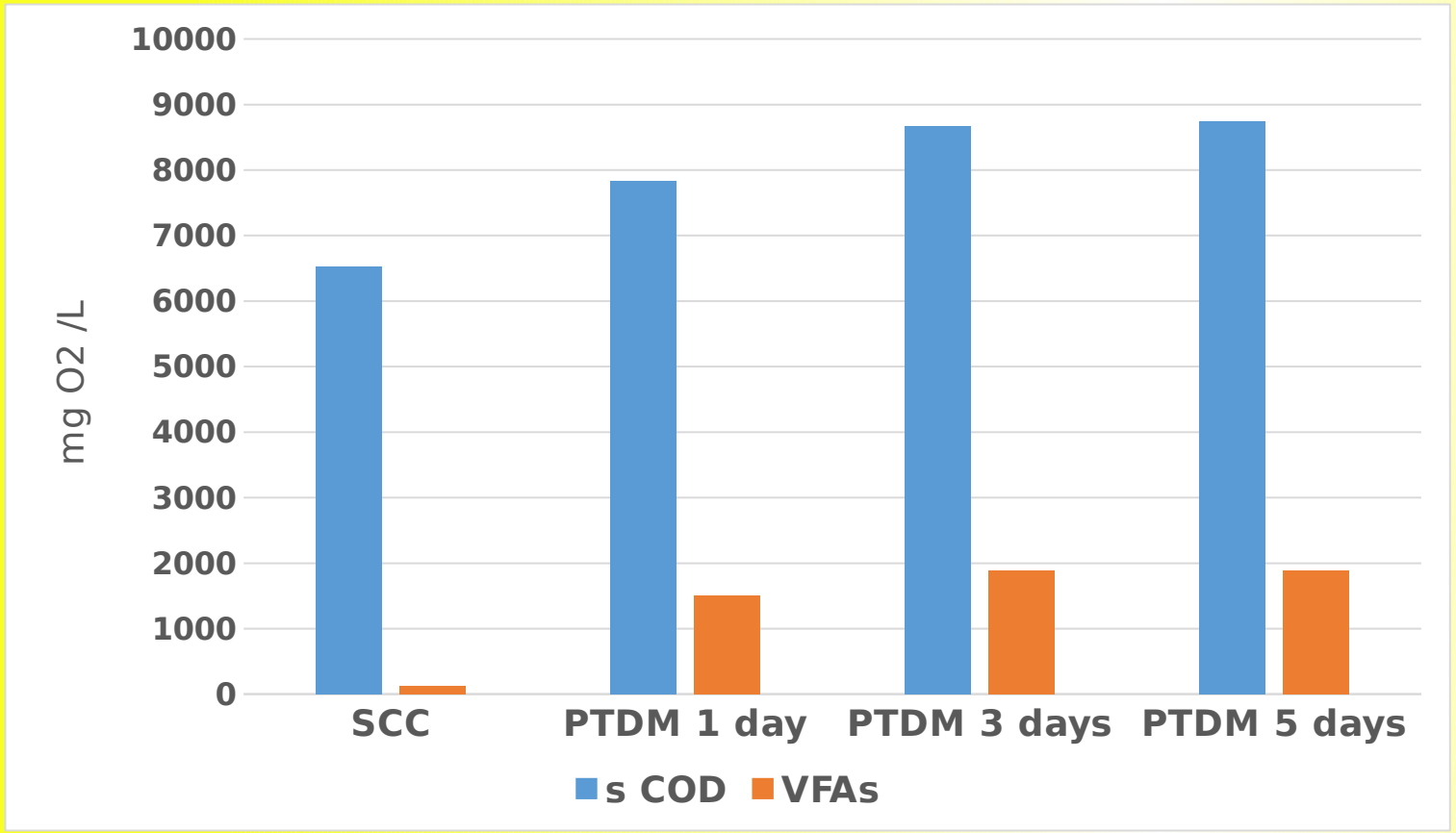


Figure shows how the 1 day - HRT contributed to an important optimization of sCOD and VFA concentrations compared to the SCC test, with an increasing of more than the 15% and 55%, respectively. Anyway, longer HRT of 3 days brought to further sCOD and VFA productions' increasing at 25% and 65%, respectively. Instead, a HRT of 5 days did not lead to better performances.

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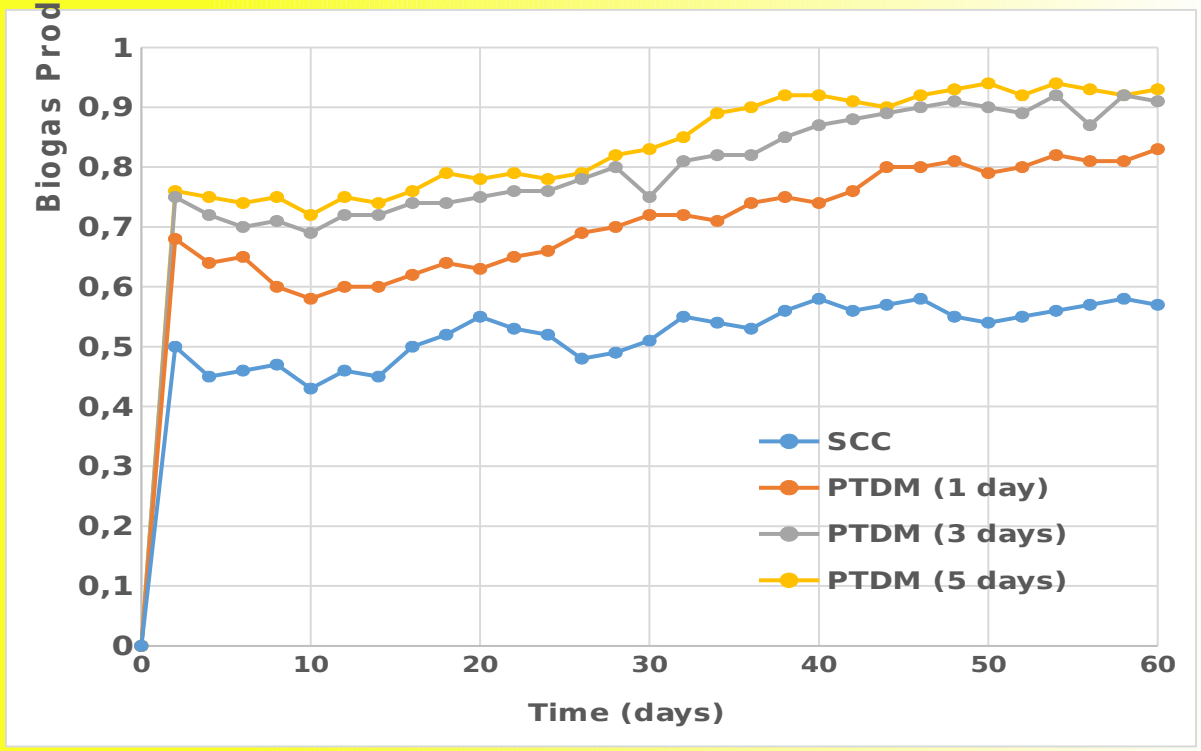
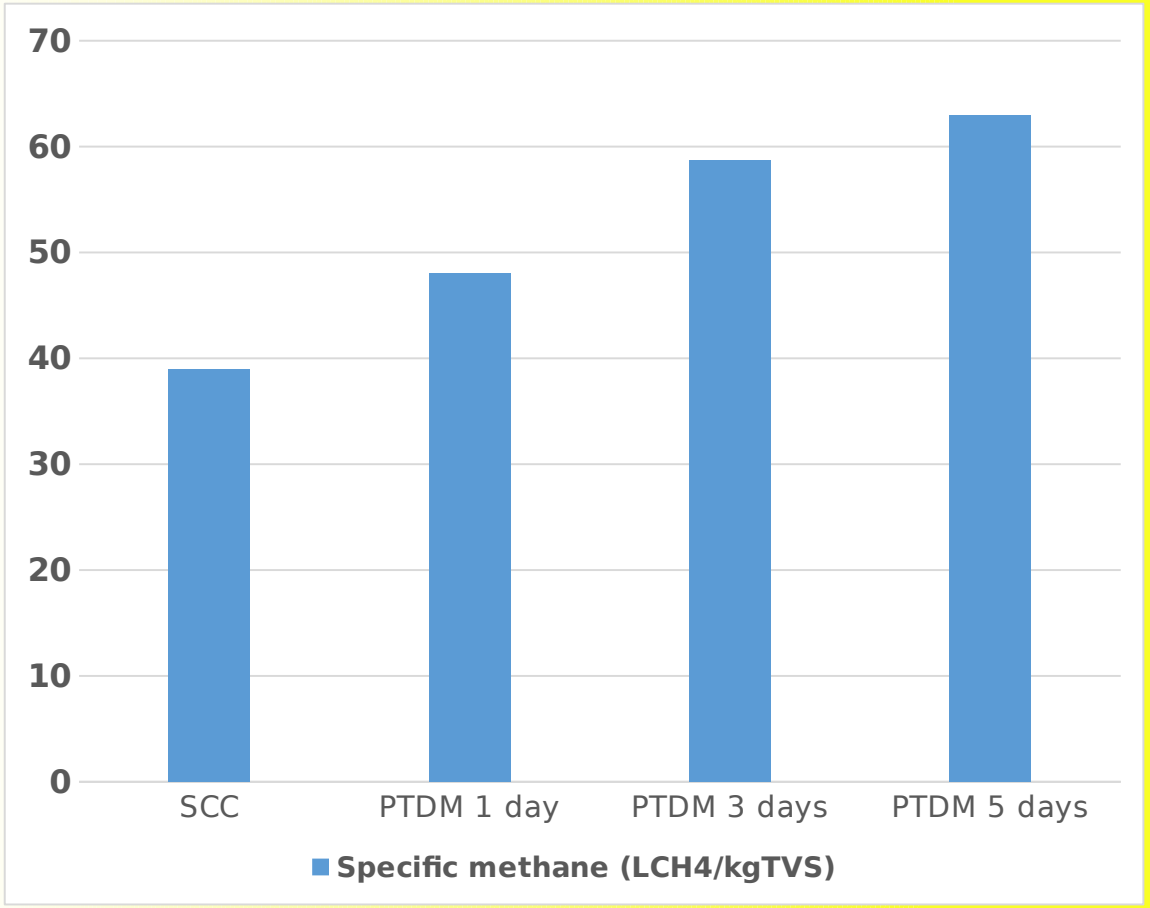
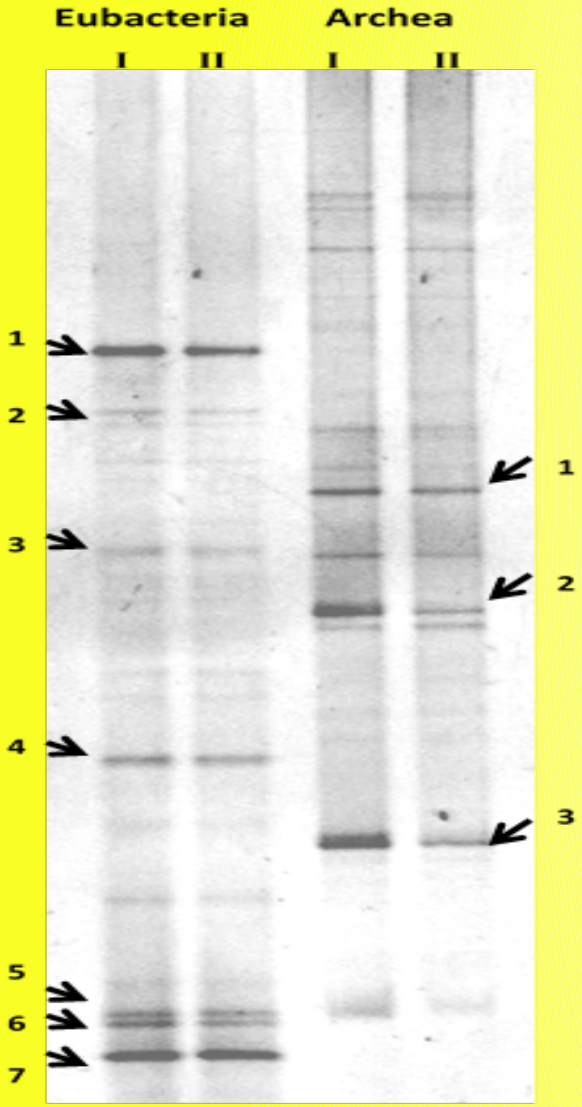
## SEMI-CONTINOUS TESTS






## PCR-DGGE analysis on Eubacteria and Archea communities

Sequencing analyses revealed that the main phyla for Eubacteria were *Firmicutes, Bacteroidetes, Actinobacteria and Thermotogae*.

Regarding Archeal community, we found members of *Methanosarcina*, *Methanobacterium* and *Methanothermobacter* genera. Also in the case of Archea, these results are in accordance with previous studies which showed an increase of *Methanosarcina* and *Methanothermobacter* genera under thermophilic conditions in anaerobic digesters

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# Thanks for the attention

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