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THESSALONIKI2021

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Session XXIV Recovery of materials from wastewater & sludge – Sludge management

Effects of the applied organic loading rate on the selection of a PHA-storing biomass in a Sequencing Batch Reactor with uncoupled Carbon and Nitrogen feeding

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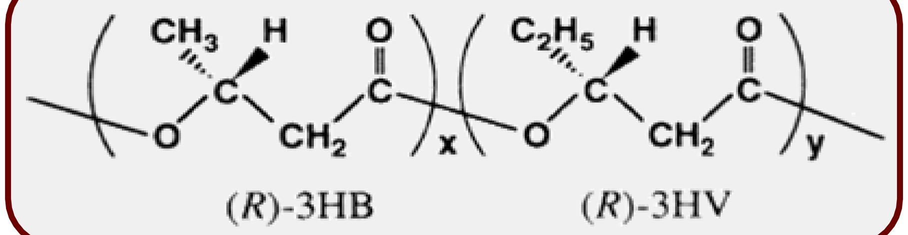
SAPIENZA UNIVERSITÀ DI ROMA

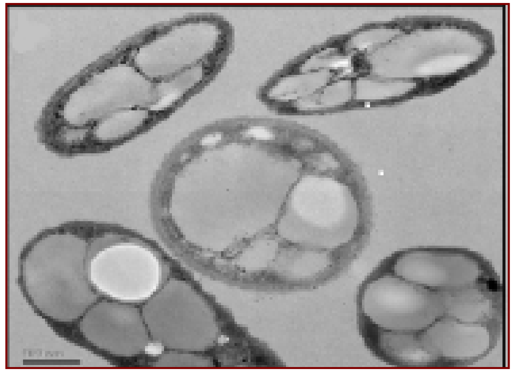
Polyhydroxyalkanoates (PHA)

Product related Pro's

Family of copolymers with tunable composition

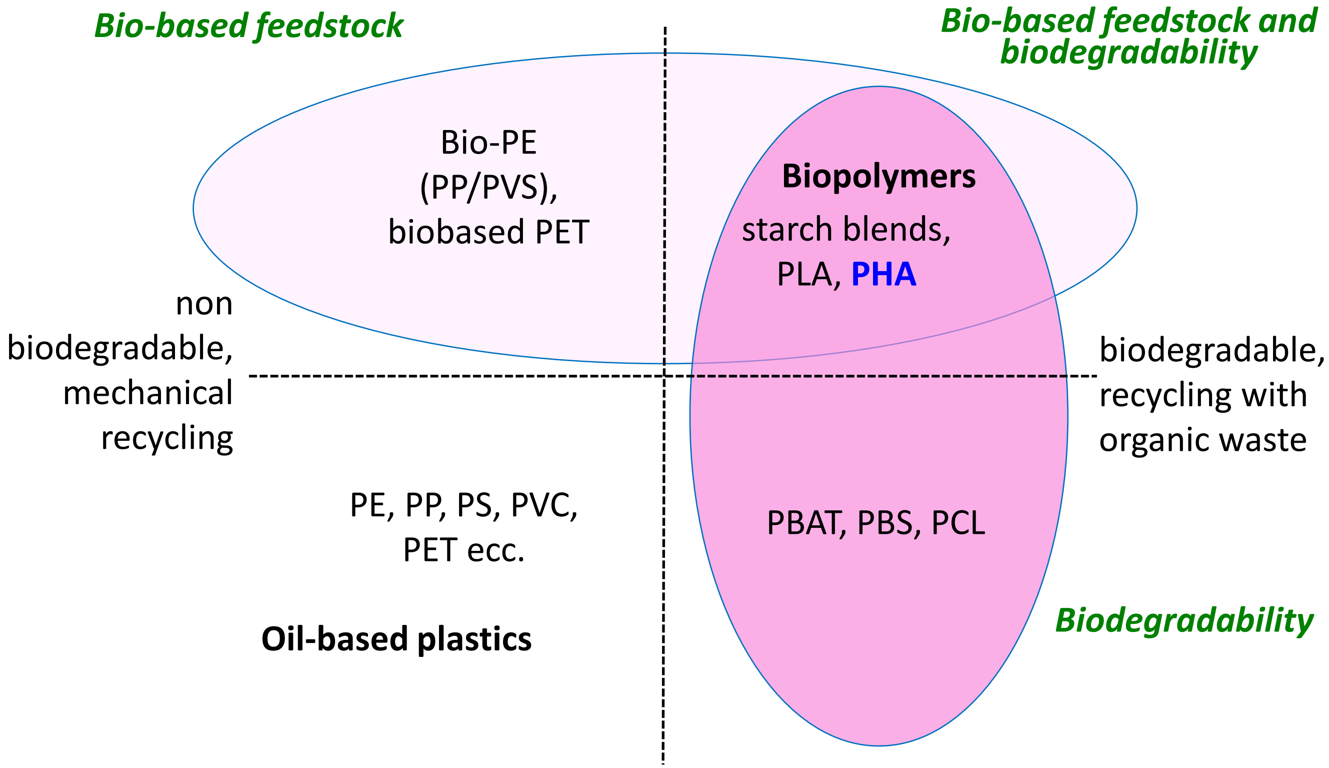
Main constituent of several bioplastics



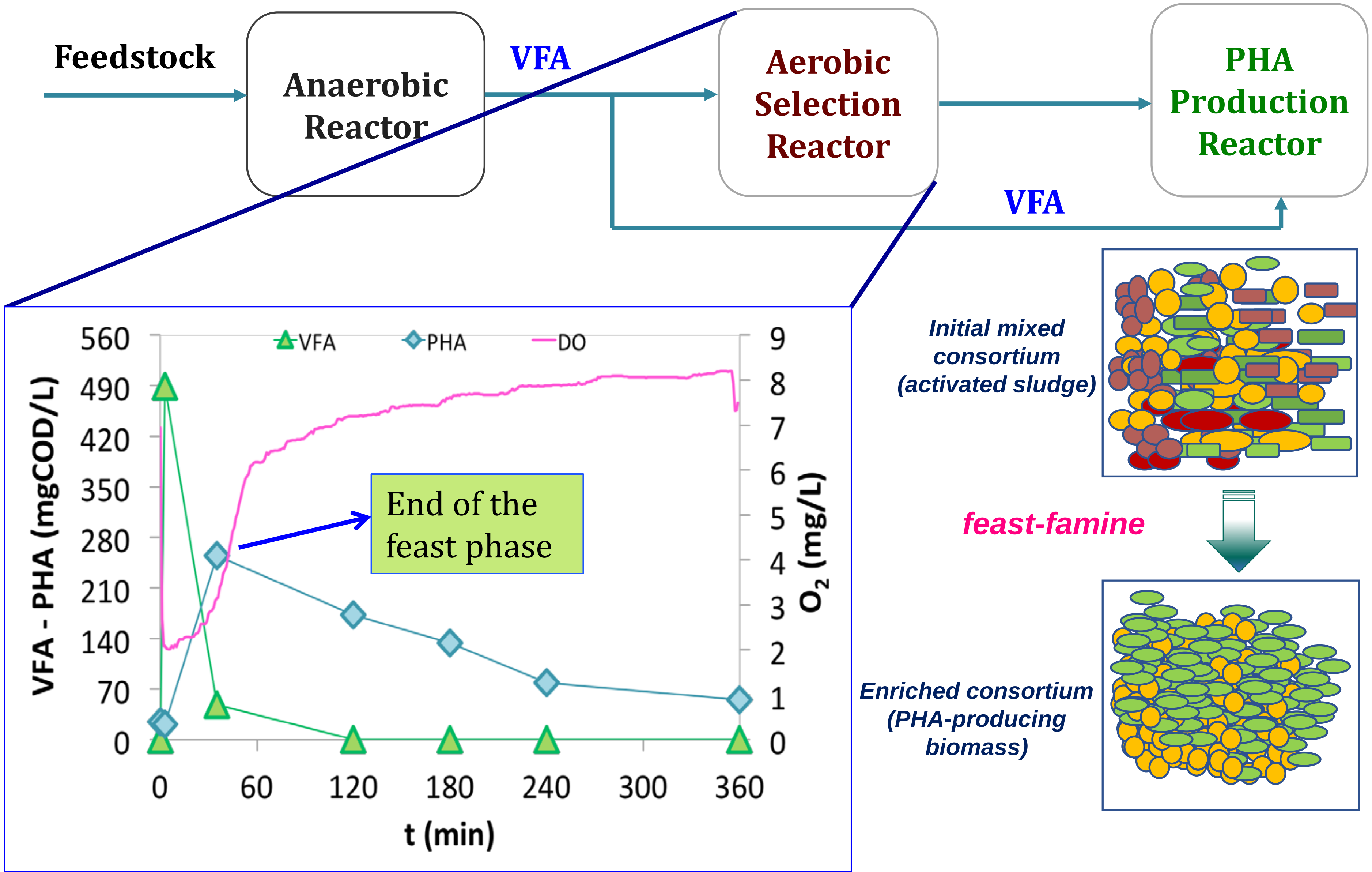


(Kunansudari, Exp Polym Let 2010)

- Biodegradable commodity film
- Packaging interlayer film
- Specialty durables (such as electronics)
- Slow C-release system for groundwater remediation



Microbial mixed cultures process



Aim of the study

Selection and enrichment of a PHA-producing biomass by applying an uncoupled C/N strategy

✓ *Influence of the increasing applied OLR* ➔ 4.25 gCOD/L d (Run A)

8.50 gCOD/L d (Run B)

12.75 gCOD/L d (Run C)

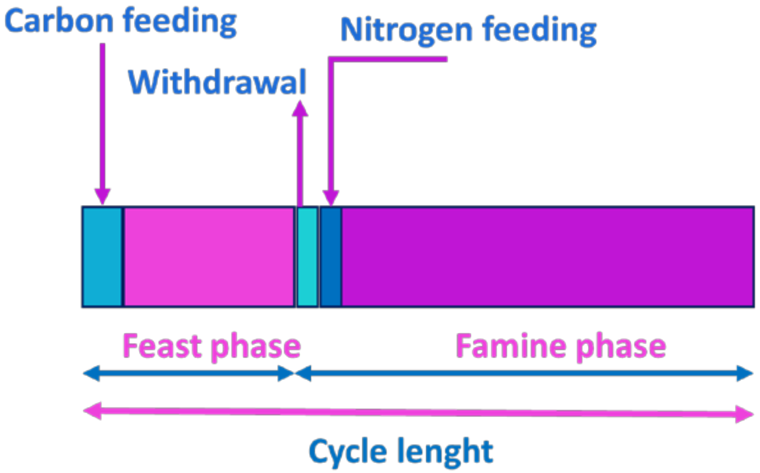
✓ *Comparison with a previous study* (Lorini et al., 2020)

✓ *Exploring a higher OLR* ➔ 18.0 gCOD/L d (Run D)

Lorini L., Di Re F., Majone M., Valentino F., High rate selection of PHA accumulating mixed cultures in sequencing batch reactors with uncoupled carbon and nitrogen feeding, *New Biotechnology, 56 (2020) 10.1016/j.nbt.2020.01.006.*

Selection of PHA-producing biomass (SBR)

Operative cycle (12 h)



Feeding = 10 min

Feast phase = 140 min

Withdrawal = 3 min

Nitrogen feeding = 5 min

Famine phase = 562 min

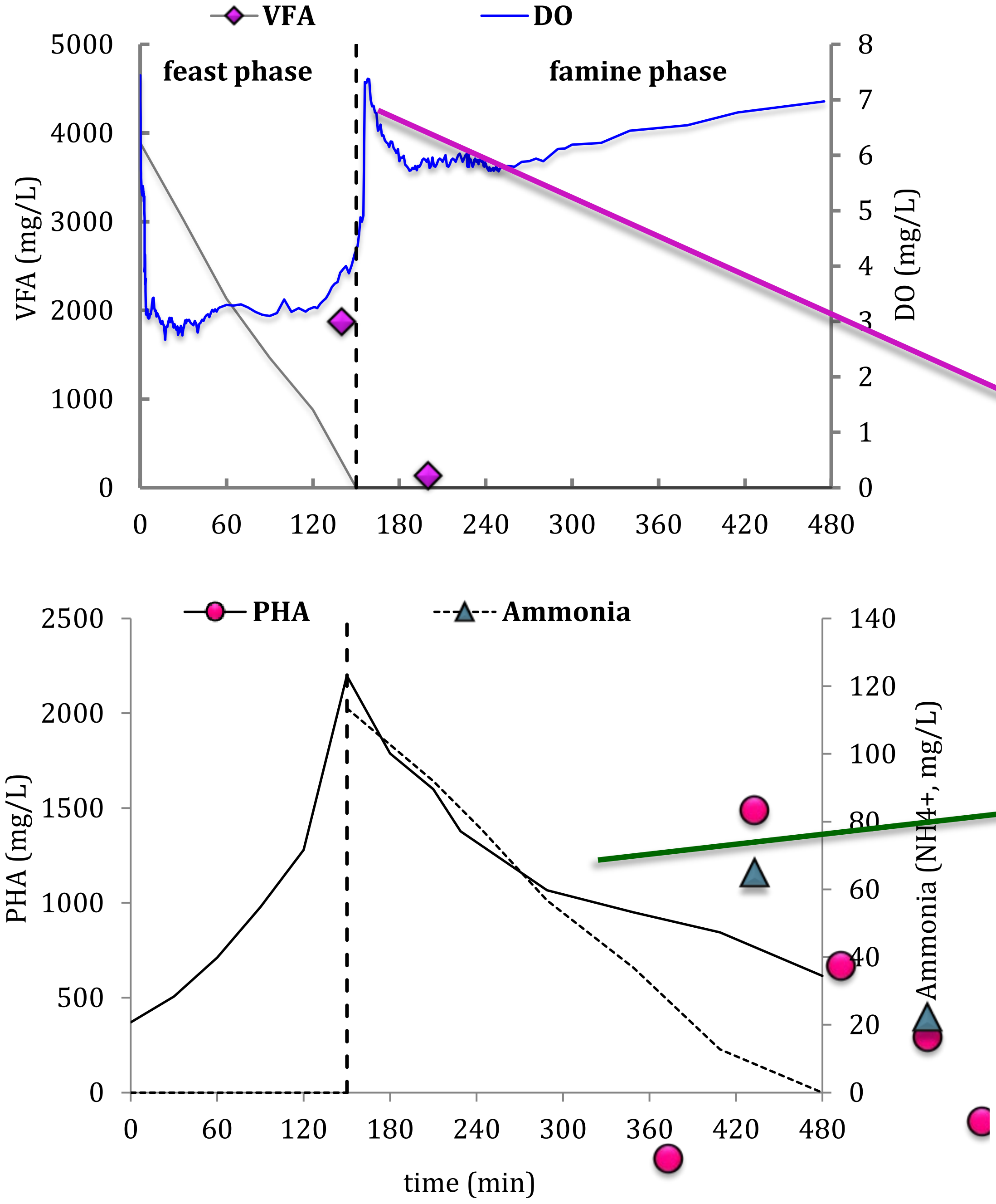
Working volume = 1L

Organic load rate (OLR)

4.25; 8.5; 12.75; 18.0 gCOD/L d

VFA (85% Acetic acid; 15% Propionic acid)

T= 25°C



VFA, DO, PHA, NH_4^+ trends during a complete SBR cycle

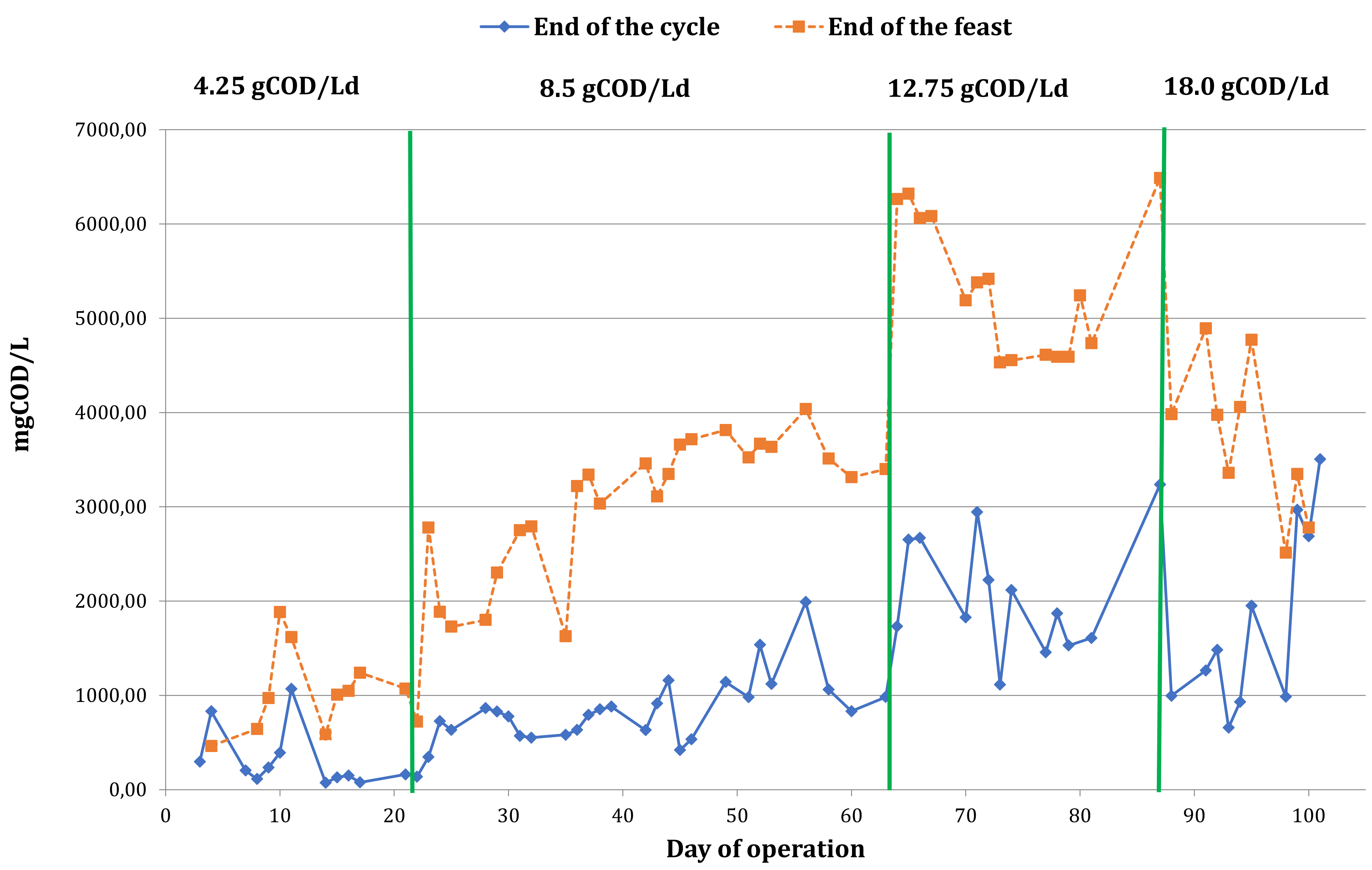
Run B

OLR = 8.5 gCOD/L d

- Complete VFA depletion
- N-feeding

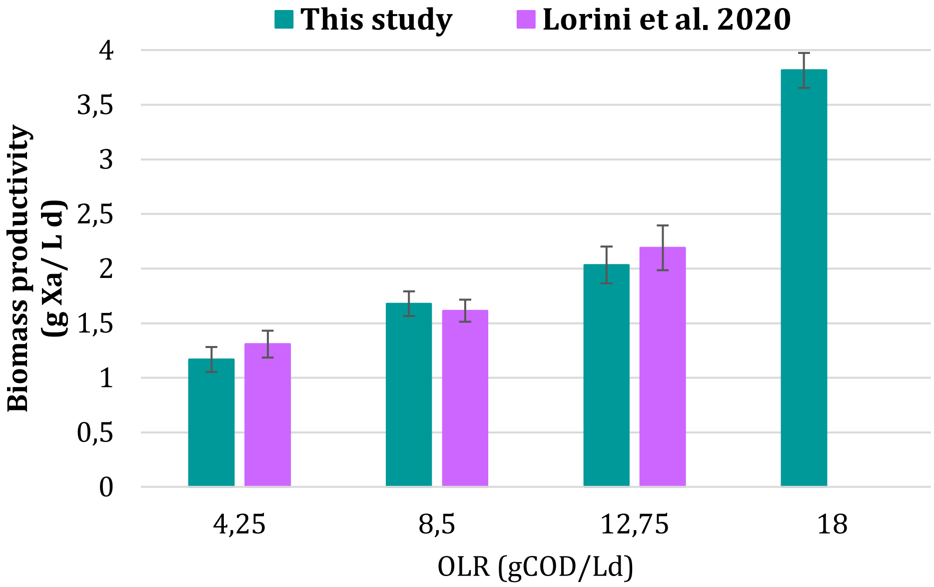
PHA and NH_4^+ consumption

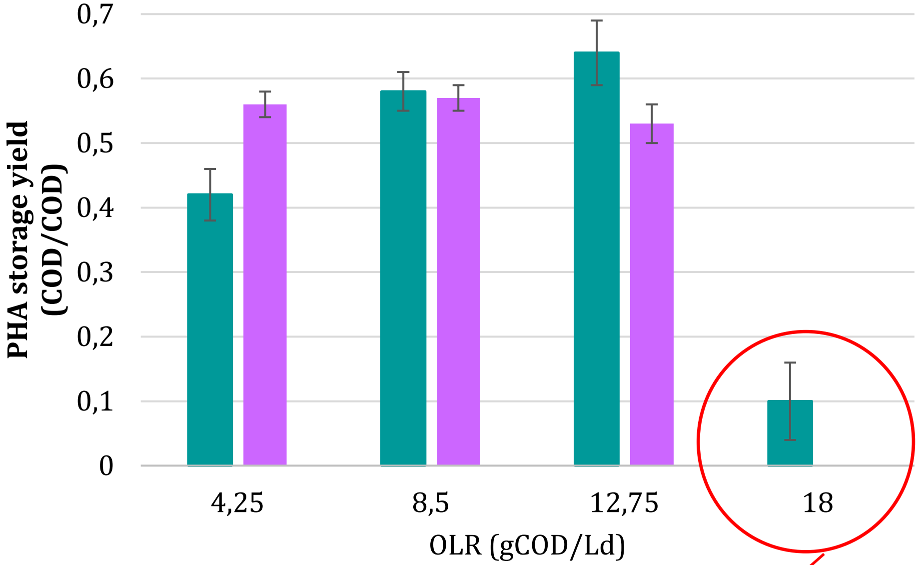
Good selective pressure on the microbial consortium

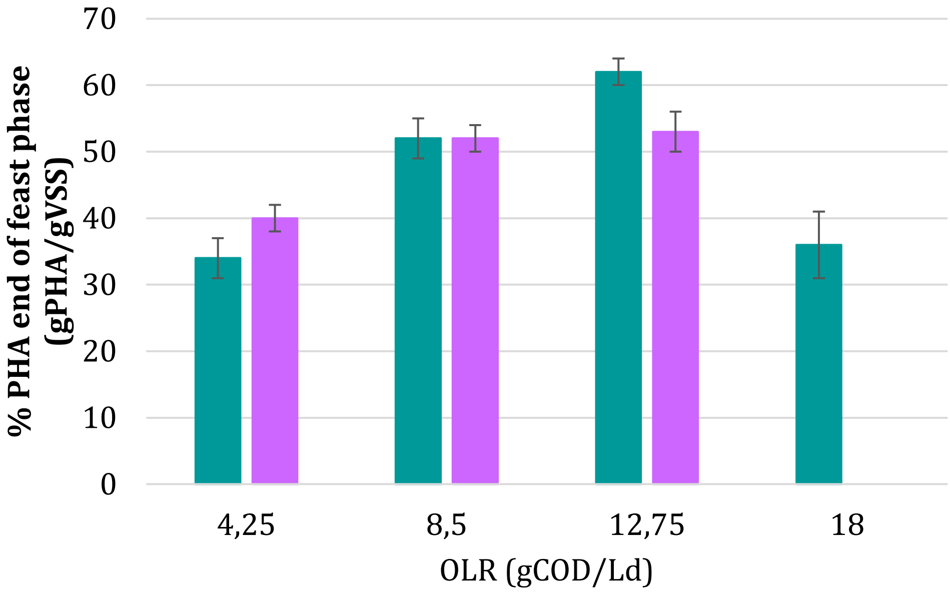


End of the cycle
End of the feast
4.25 gCOD/Ld
8.5 gCOD/Ld
12.75 gCOD/Ld
18.0 gCOD/Ld
mgCOD/L
7000,00
6000,00
5000,00
4000,00
3000,00
2000,00
1000,00
0,00
0
10
20
30
40
50
60
70
80
90
100
Day of operation

Comparison with the previous study







Dramatical decrease of the $Y_{P/S}$

Parameters	Run A	Run B	Run C	Run D	*(Lorini et al. 2020)*		
OLR (gCOD/L d)	4.25	8.5	12.75	18	4.25	8.5	12.75
Feast phase/cycle length ratio (h/h, %)	29.2 ± 2.9	28.7 ± 1.5	29.4 ± 1.6	39.4 ± 2.3	21.0 ± 0.6	20.7 ± 0.3	27.1 ± 0.9
PHA concentration (end of cycle; mg/L)	76 ± 8	505 ± 40	1076 ± 121	1168 ± 256	235 ± 23	373 ± 30	658 ± 61
PHA concentration (end of feast; mg/L)	601 ± 50	1780 ± 80	3080 ± 121	2049 ± 110	807 ± 58	1639 ± 40	2389 ± 145
PHA content (end of feast; gPHA/gVSS)	0.34 ± 0.03	0.52 ± 0.03	0.62 ± 0.02	0.36 ± 0.05	0.40 ± 0.02	0.52 ± 0.02	0.53 ± 0.03
Storage Yield ($Y_{P/S}^{feast}$; COD/COD)	0.42 ± 0.04	0.58 ± 0.03	0.64 ± 0.05	0.10 ± 0.06	0.56 ± 0.02	0.57 ± 0.02	0.53 ± 0.03
HV content (end of feast; gHV/gPHA)	0.15 ± 0.02	0.21 ± 0.01	0.25 ± 0.01	0.06 ± 0.02	0.25 ± 0.01	0.24 ± 0.01	0.14 ± 0.02
Nitrogen concentration (end of the cycle; mgN/L)	20 ± 3	34 ± 3	10 ± 3	101 ± 14	14 ± 2	8 ± 1	7 ± 2

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Conclusions and future perspectives

- At OLR ranging between 4.25 - 12.75 g COD/L d, the feast/famine regime was easy established and a strong PHA-storing biomass selection was observed in line with the high storage yield
- At very high OLR (18 g COD/L d) the system was unstable and the storing capacity of the microbial community was strongly affected

- *The high PHA content achieved may allow simplifying the process by skipping the traditional accumulation step*

- *The exploitation of nutrient deficient organic waste (paper mill and olive oil mill wastewaters, cheese whey permeate or sugar-cane molasses) may be realized including a nitrogen and phosphorus addition in the famine phase*


Thanks for your attention