Volatile Fatty Acids production as PHAs precursors from candy manufacturing wastewater

M. Menini[1], V. Tosi[1], D. Bolzonella[2], F. Fatone[1], N. Frison[1,2]

[1]InnovEn Srl, Verona (Italy);

[2]University of Verona, Verona (Italy)

AFTERLIFE has received funding from the Bio-Based Industries Joint Undertaking under the European Union's Horizon 2020 research and innovation program under grant agreement No. 745737 .

Outline

- Food/Sweet & beverage industries consume around 4.9 m^3/inhabitant-year of water (Eurostat, average from 2003 to 2011);

- Around 3700 Million m^3/year of wastewater are genereted;

- Typically treated in-situ and/or in a municipal wastewater treatment plant (MWWTP)

  -> Treatment Cost/Disposal: up to 10 €/m^3

- High concentration of organic compounds (mainly soluble) and very biodegradable, not properly valorized yet;

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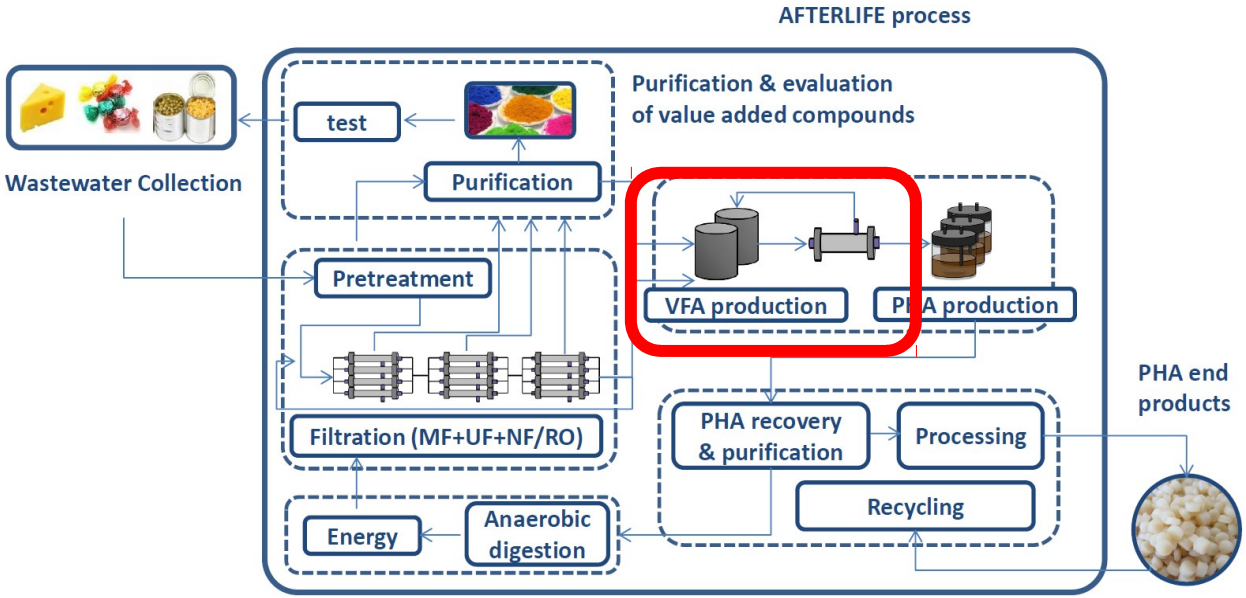
Advanced Filtration TEchnologies for the Recovery and Later converslon of relevant Fractions from wastewater (AFTERLIFE)



14 Partners
-10 SME
-4 Research Organizations

3 food/sweet industries:

- Candies;
- Cheese;
- Lemon and essential oil

Total budget around 4 M€

Impact for the society

- Recovery and valorization of nutrients and organic matter from wastewater;
- Reduction of CO_2 equivalent per unit of bioplastic produced (< 3 ton/ton);
- Recovery of pure water > 70% of the initial WW volume;
- Increased EU competiiveness: expected PHA final price < 3 €/kg.

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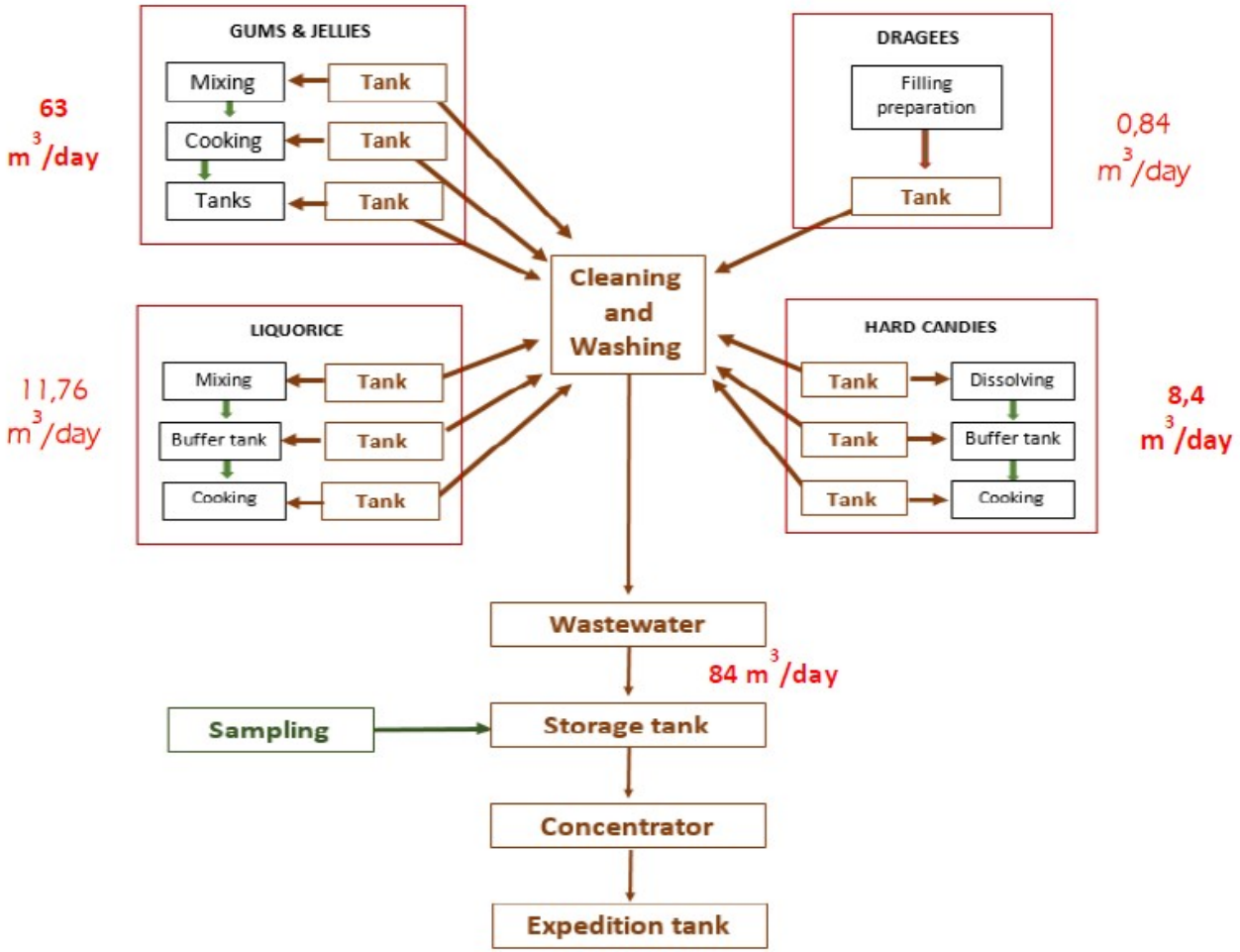
Production of candy manufacturing wastewater



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Objectives

- To study the effect of pH and type of inoculum on the VFAs productivity under batch conditions;
- To assess the best performances in terms of VFAs productivity and yields in a Sequencing Batch Fermentation Reactor;
- To evaluate the final VFAs compositions

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Characteristics of the Candy WW

Parameter	Unit	Average	Min	Max
TS	gTS/kg	82	57	123
TVS	gTS/kg	79	52	120
COD	g/L	81,6	53,5	126
sCOD	g/L	74,3	51,6	104
TKN	mgN/L	582	404	874
PO_4-P	mgP/L	121	84	182

Relatively high content of Total Solids (>95%TVS), although is «wastewater»;

The COD is mostly in soluble form (around 90%);

High COD/N and COD/P ratio favour the PHA production

Horizon 2020 European Union Funding for Research & Innovation

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Experimental Setup

Batch tests	Batch Conditions	
pH	5.5; 7.0; 3.5 (not controlled)	
	Buffered	Not buffered
Substrate/ Inoculum ratio	1:1 (COD based)	
Type of inoculum	Activated sludge from municipal WWTP Anaerobic digestate from biogas plant (treating agro-waste materials)	

Batch temperature: 37°C

Duration: 7 days

Biogas production was monitored and recorded

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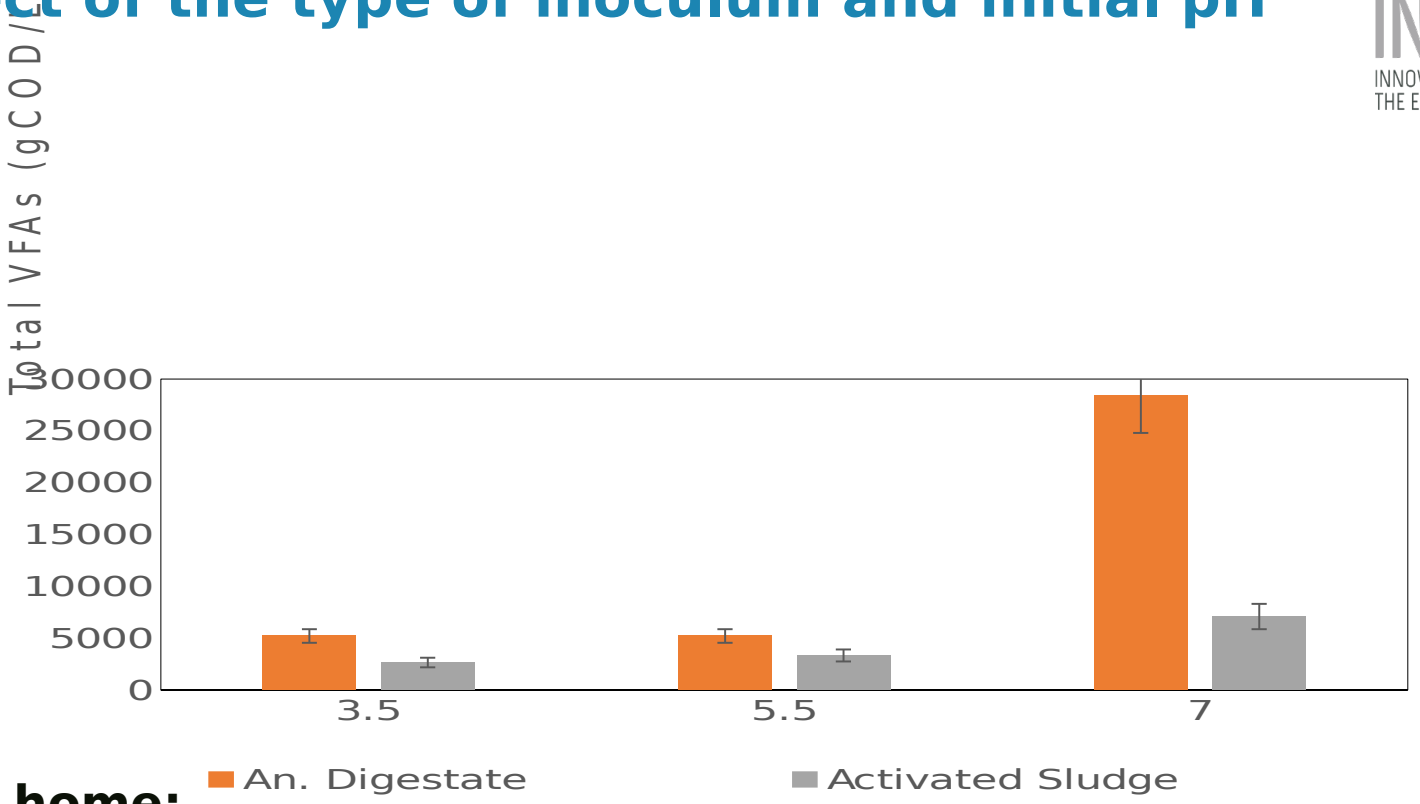
Effect of the type of inoculum and initial pH



Take home:

- The pH influence the production of VFAs;
- Type of inoculum play an important role during the start-up of the fermentation reactor;

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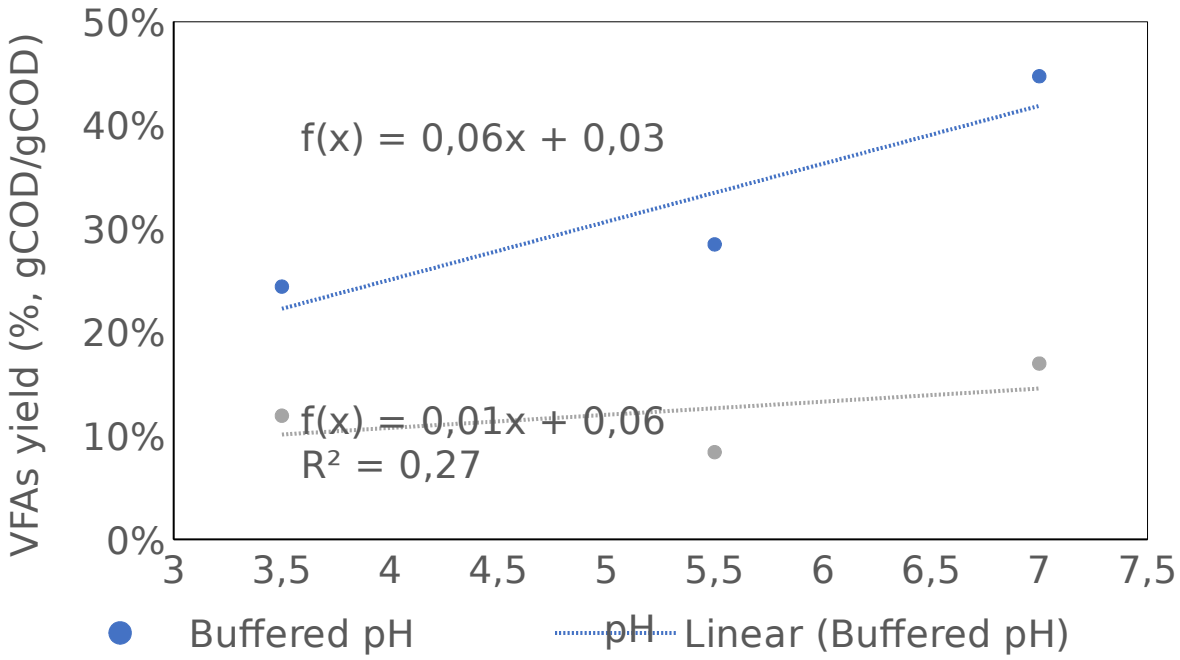
Effect of the pH control on VFAs production



Maximal VFAs concentration were achieved after **4-5 days** of fermentation

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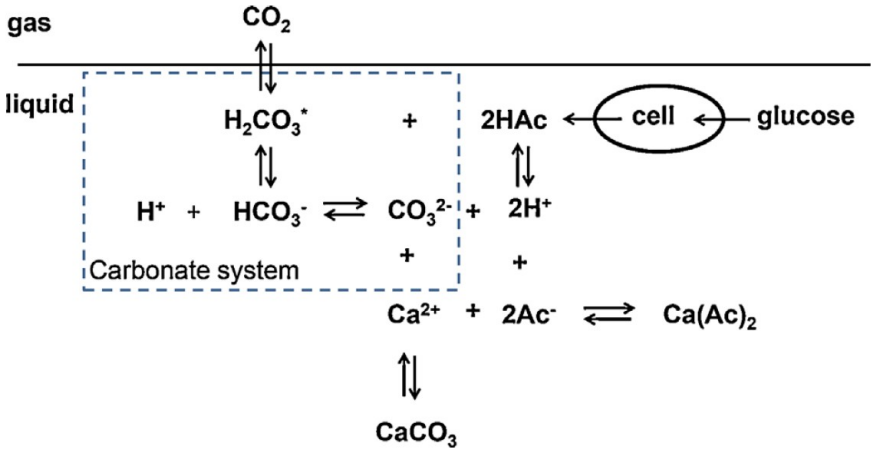
Operating conditions of the Sequencing Bathc Fermentation Reactor

Working volume: 5 liters

Parameter	Unit	Run 1 (0-42)	Run 2 (43-97)	Run 3 (98-140)
HRT	day	2	2	4
Temperature	°C	37±1	37±1	37±1
vOLR	$kgCOD/m^3 day$	43±5	38±6	26±2
Alkaline Source	-	-	$CaCO_3$	$CaCO_3$



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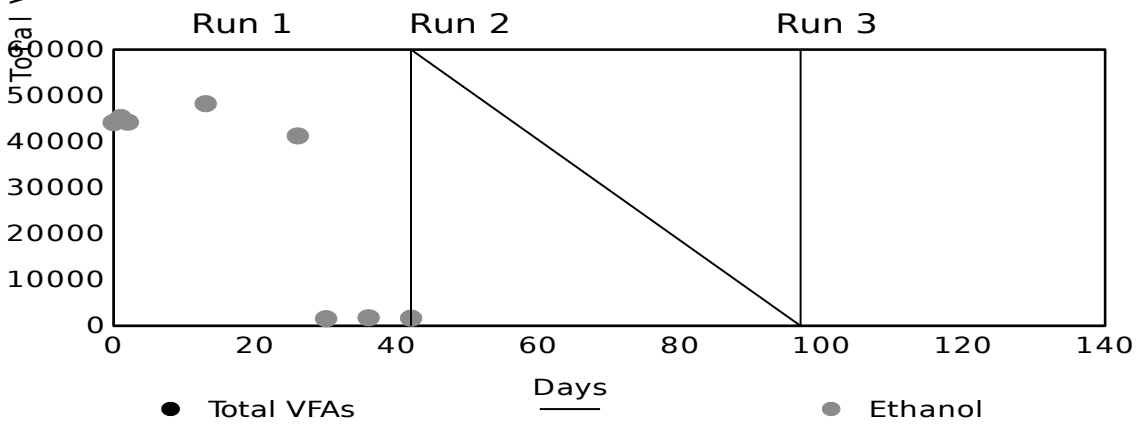
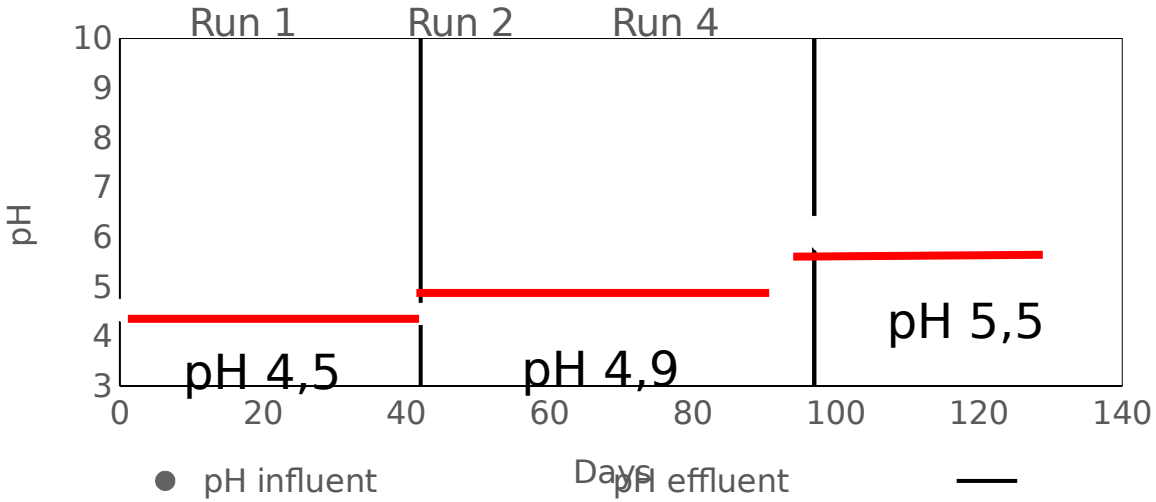
Long term VFAs production





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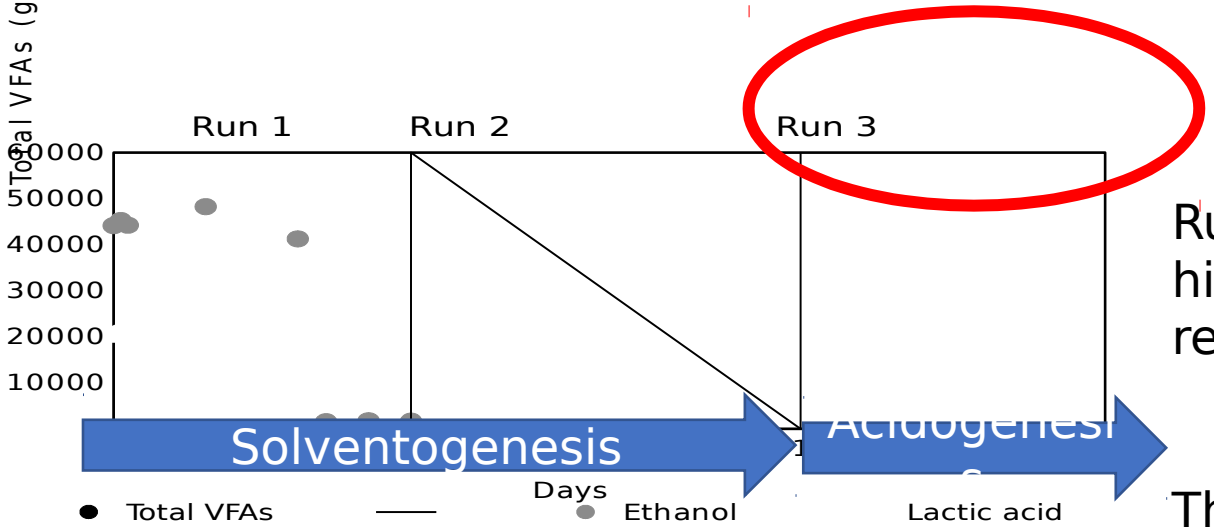

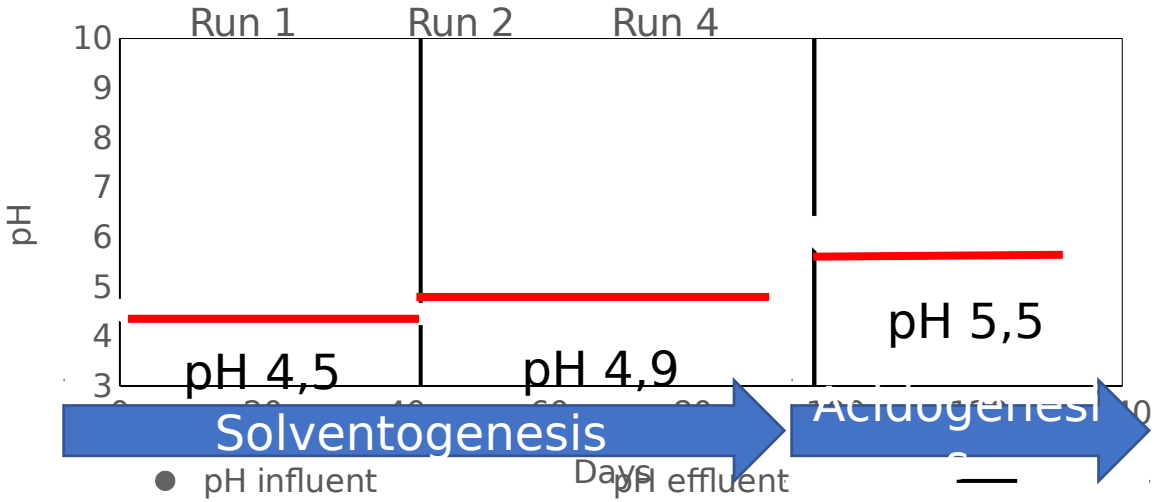

Run 3 (HRT = 4 days), higher alkalinity is retained in the reactor

The pH-induced metabolic shift from solventogenesis to acidogenesis

For pH higher than 5,2-5,5, the VFAs concentration increased up to 40-50 gCOD/L

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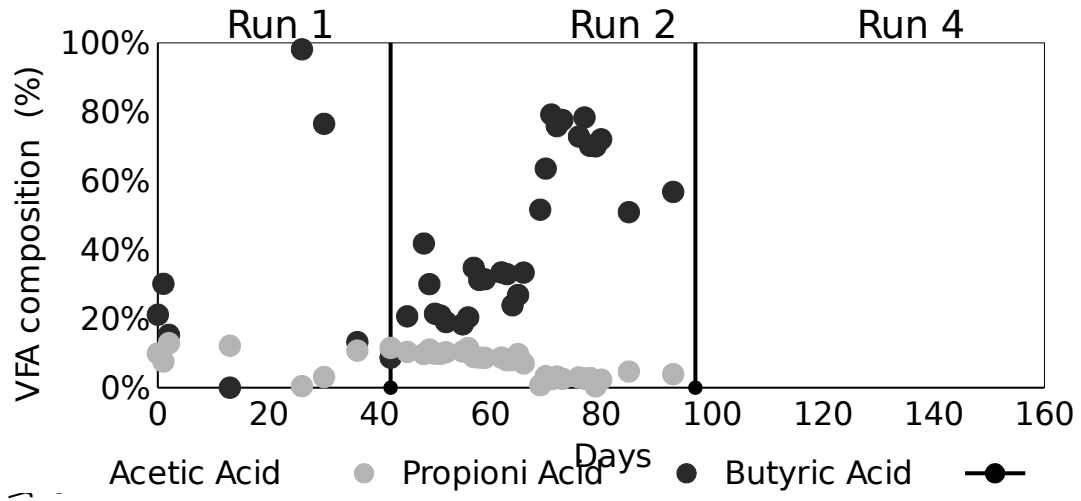
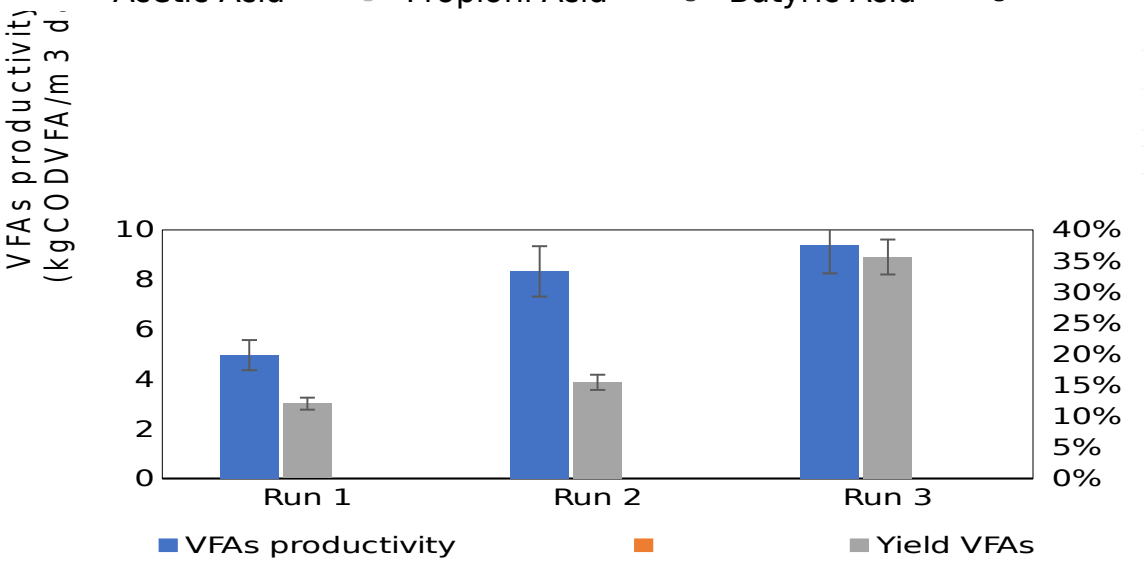
Long term VFAs production





- Butyrate was the main type of acid produced (up to 80%)
- In run 4, the observed VFAs productivity was around 10 $kgCOD_{VFA}/m^3$ reactor day;
- In run 4, around 36-40% of the COD influent was converted to VFAs

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Conclusions

- The BBI - AFTERLIFE project aims at the valorization of wastewater from food processing through the recovery of added value compounds (e.g., PHAs)
- Wastewater from candy manufacturing represents a relevant source of biodegradable carbon for biorefinery purposes;
- pH was foundamental to shift the metabolism from solventogenesis to acidogenesis
- Around 36-40% of the COD could be converted to VFAs, mainly as butyric acid (80%)
- The VFAs productivity were around 10 kgCOD/m^3 day, operating at HRT of 4 days

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Thank you for your attention

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