A holistic approach for the utilization of an industrial sugary wastewater towards biofuels and bioplastics production

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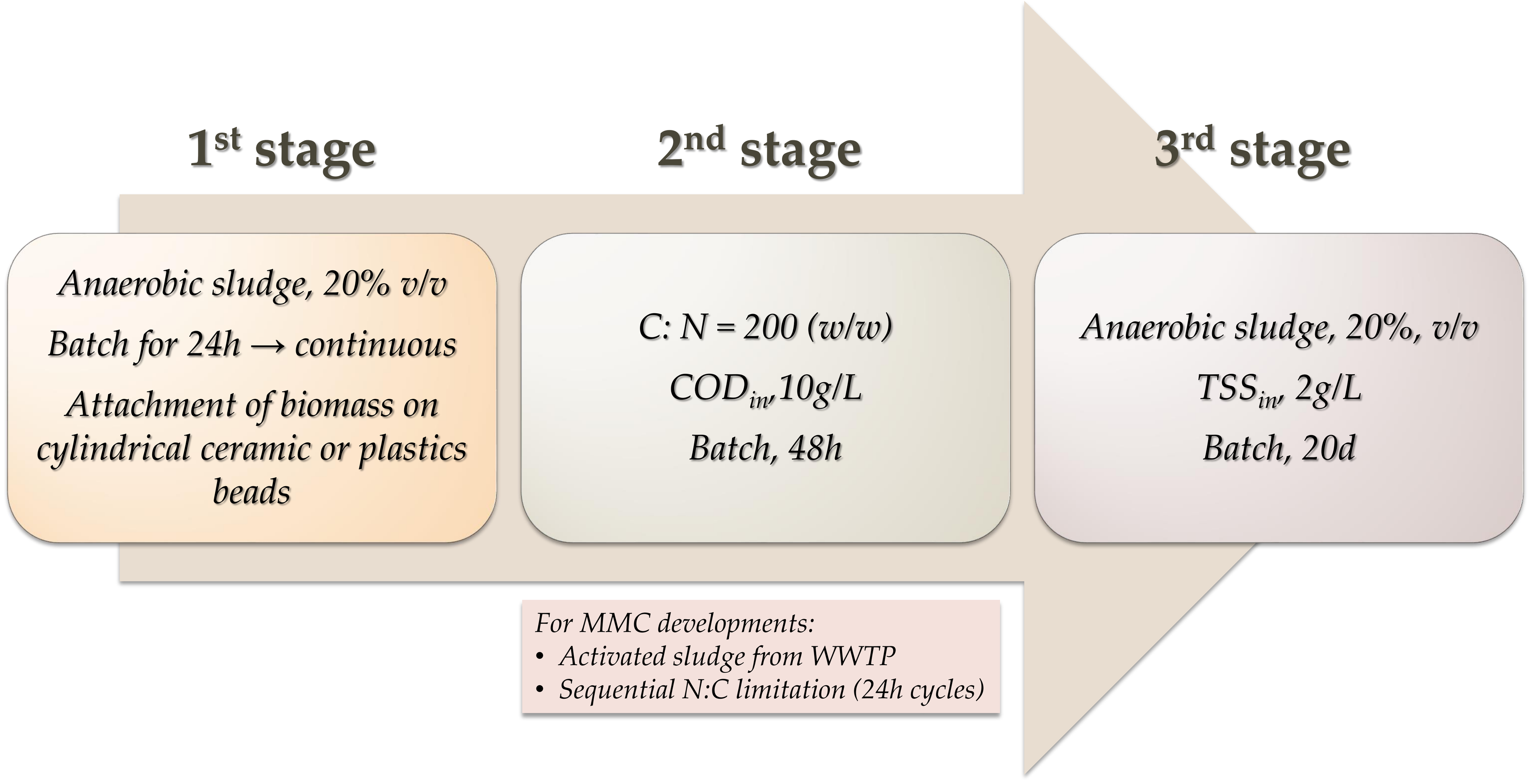
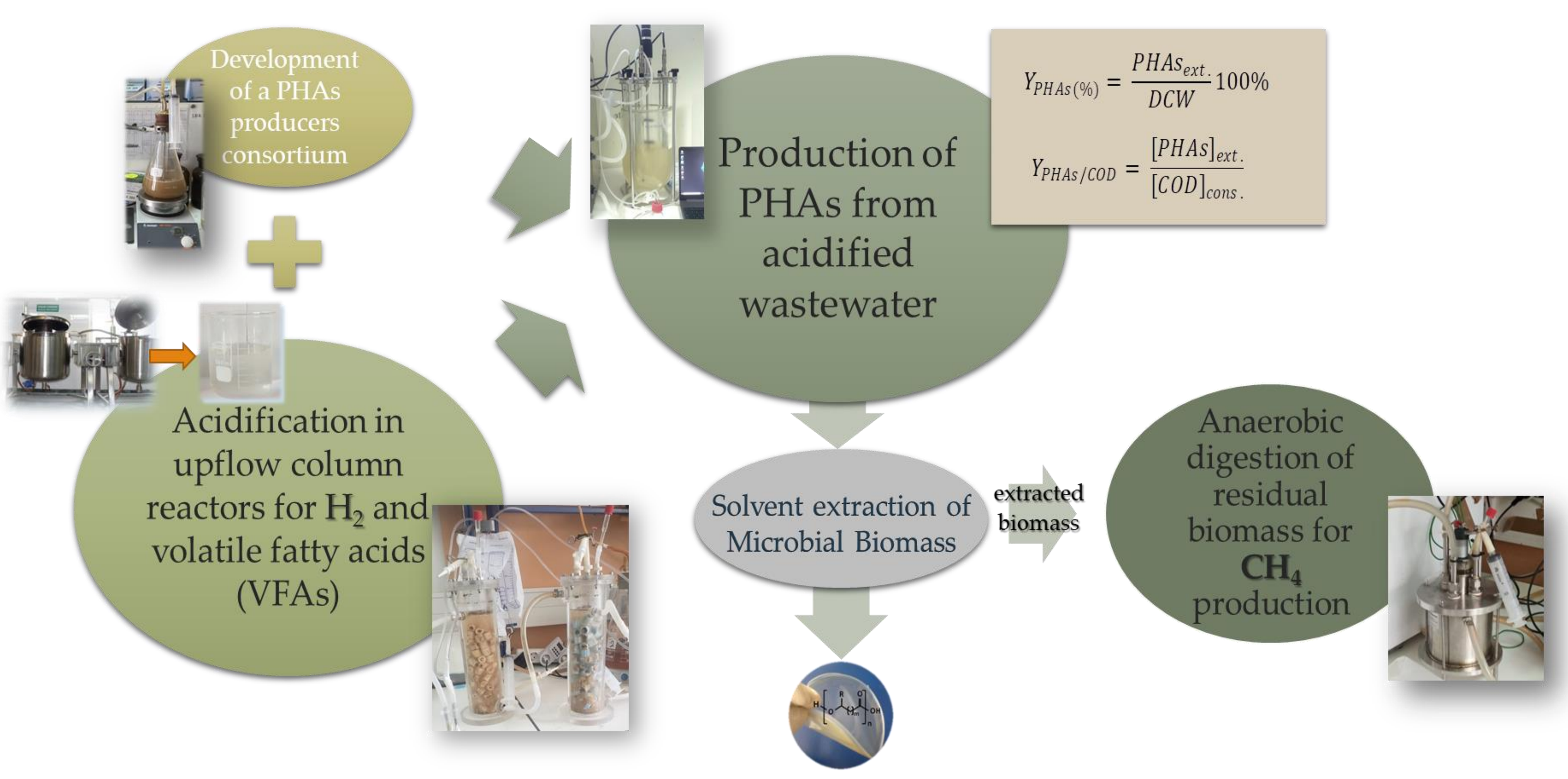
INTRODUCTION: Biohydrogen and methane are biofuels that represent clean and green energy carriers, since they can be generated from renewable sources and their production for energy release is accompanied by minimal by-products i.e. carbon dioxide and/or water. Methane production through wastes is a mature technology, already broadly applied. In biological hydrogen production processes, hydrogen formation is accompanied by the generation of volatile fatty acids (VFAs) which can be exploited serving as precursors of polyhydroxyalkanoates (PHAs) i.e. microbial bioplastics. PHAs bear similar properties to fossil plastics, being also fully biocompatible, biodegradable and non-toxic, but their industrialisation is so far hampered by their high production cost. If their production is though based on the exploitation of zero cost carbon sources, such as sugary wastewaters, the production cost could be significantly decreased, especially if coupled with the recovery of energy.

Approach & Methodology

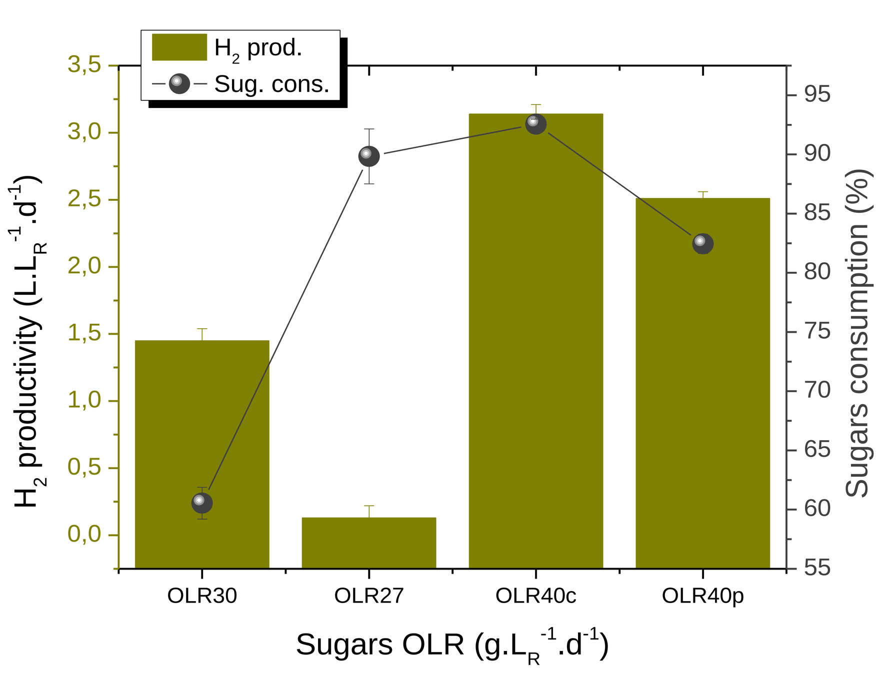
Aim: To provide a sustainable biotechnological solution for the holistic exploitation of confectionery industry wastewaters (CIWW), towards energy and bioplastics in a **three stage system**.

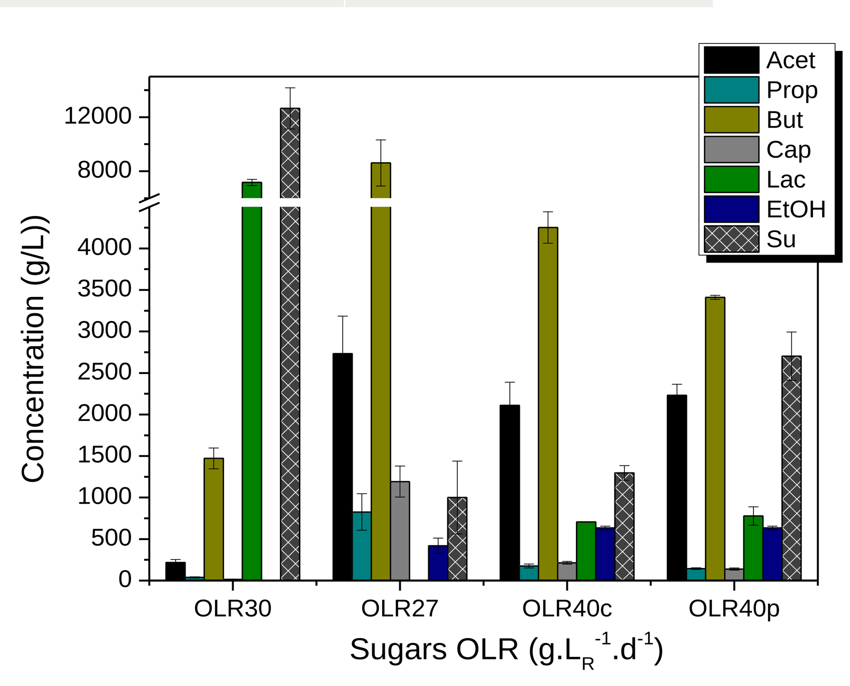




Results

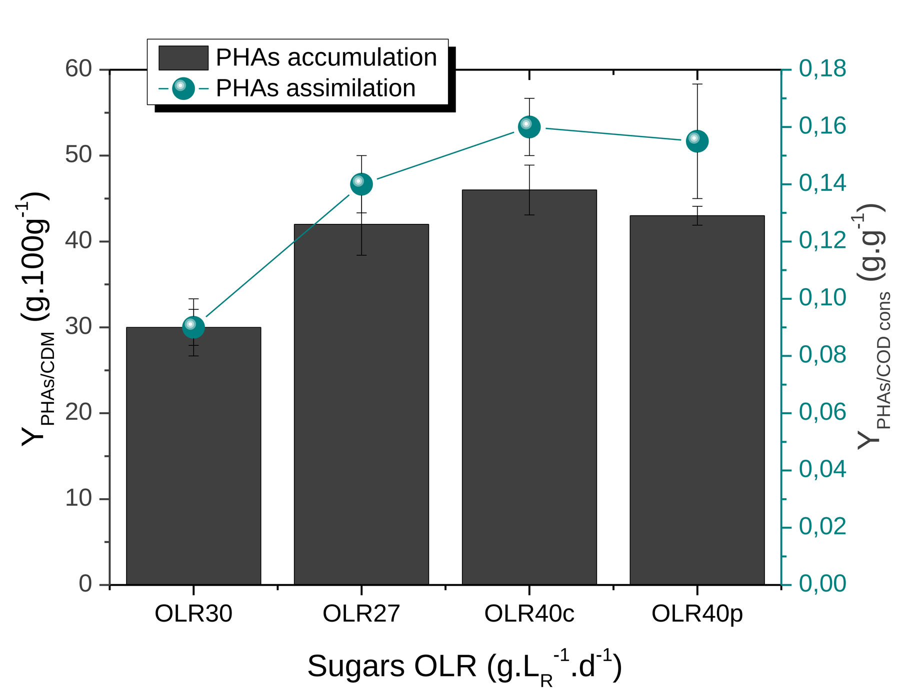
	OLR, $g.L_R^{-1}.d^{-1}$	Conditions (HRT/S_{feed}/bed/recirulation)	Y_{H2}, mol/mol su. conc.
OLR30	30	24h/ 30g/L/ ceramic/none	0.72 ± 0.19
OLR27	27	24h/ 30g/L/ ceramic/none/50% V_w	0.04 ± 0.02
OLR40c	40	12h/ 20g/L/ ceramic/none	0.76 ± 0.02
OLR40p	40	12h/ 20g/L/ plastic/none	0.68 ± 0.02

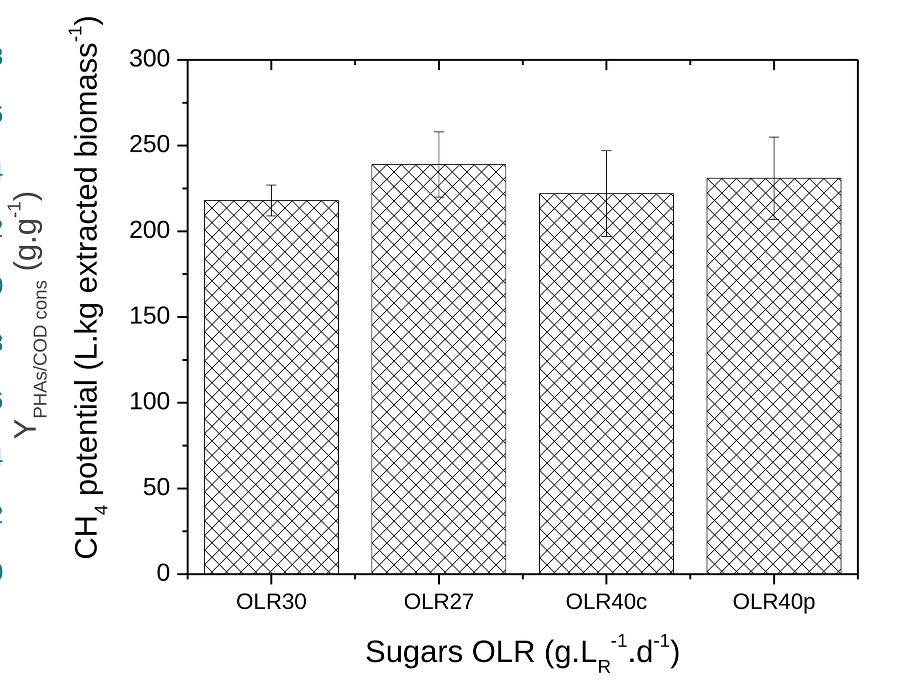




1st stage

- Maximum consumption of sugars as well as hydrogen productivity and yield are noted for OLR 40$g.L_R^{-1}.d^{-1}$
- Lower substrate concentration of feed favours consumption and yields
- Recirculation allows consumption of residual sugars but inhibits hydrogen production
- Better performance of the system for ceramic supporting medium
- High substrate concentration of feed leads to dominance of lactate
- Recirculation leads to dominance of butyrate (from lactate) and considerable production of propionate (~750 hmg/L)
- The type of supporting medium does not affect the relative distribution of metabolites





2nd stage

- Lower PHAs yields noted for the effluent containing mainly lactate and sugars
- In all other cases the yields were not significantly different
- In all cases, the polymers were identified to be the co-polymers **PHBHV**, but only by OLR27 a considerable amount of HV was achieved, ~4%

3rd stage

- Biochemical methane potential of the post-extraction microbial biomasses was not significantly different, and into the range of methane that can be produced from different types of biomass

Conclusions

- *Complete bioconversion of the sugars of the CIWW can be achieved during acidification towards H_2 and volatile fatty acids, by altering the operational parameters of the system*
- *Efficient assimilation of the carbon sources of the acidified CIWW can be achieved by the MMC, with high accumulation capacity*
- *The solvent extraction of PHAs does not affect anaerobic digestion allowing extra energy recovery, thus contributing to the sustainability of the process*

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