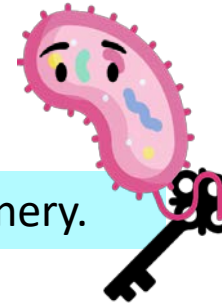


# Towards understanding the role of product concentration on acidogenic fermentation yield and profile

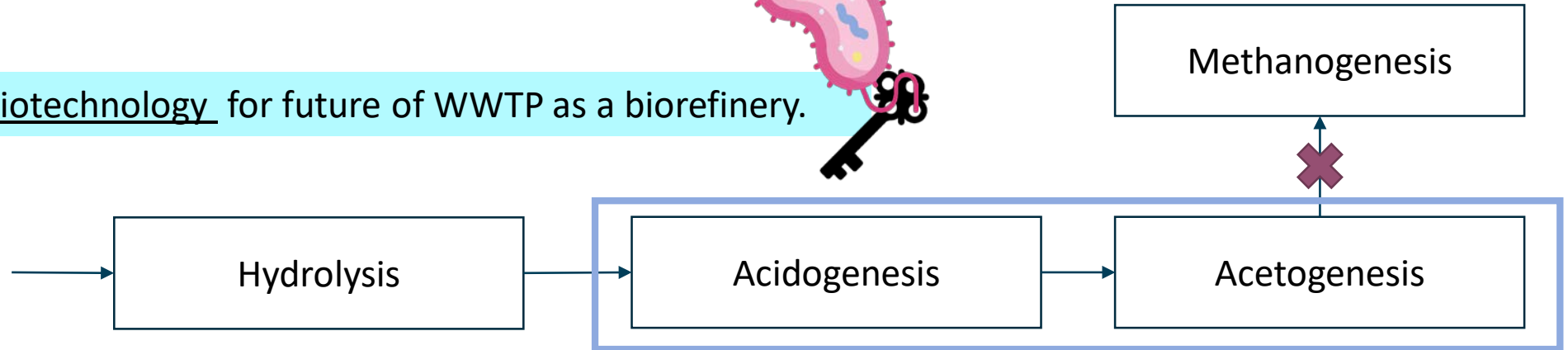
**Noemí Perez-Esteban**, Carme Vidal-Antich, Miriam Peces, Joan Dosta and Sergi Astals

# INTRODUCTION

Fermentation is a key biotechnology for future of WWTP as a biorefinery.



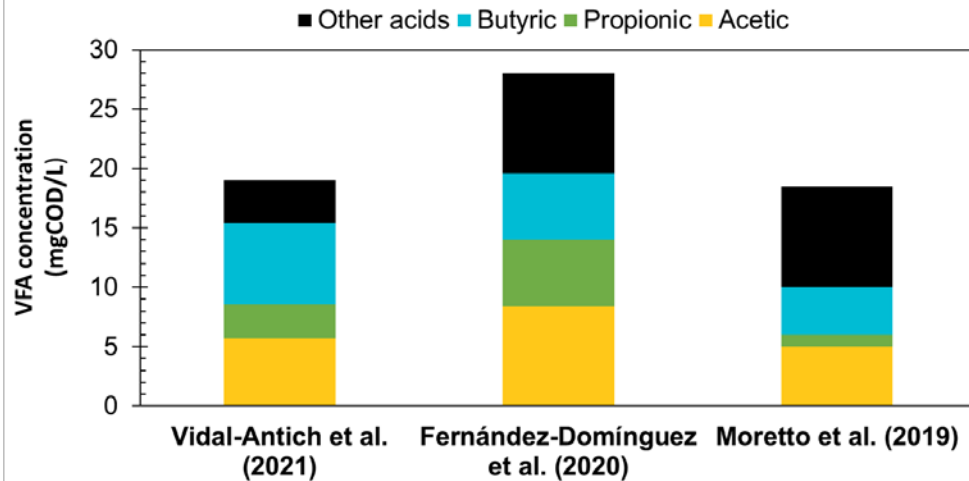
Complex particulate waste



VFA, alcohols, lactic acid

Use for other biotechnologies like PHA or BNR

Concentrations obtained in co-fermentation articles with FW, at pH of 5-6.



Vidal-Antich, et al. (2021). <https://doi.org/10.1016/j.scitotenv.2020.143763>.  
Fernández-Domínguez, et al (2020). <https://doi.org/10.1016/j.biortech.2020.123729>  
Moretto, et al. (2019). <https://doi.org/10.1016/j.wasman.2019.05.010>

# OBJECTIVE



**To study the impact of acetic, propionic, and butyric acid addition on the acidogenic fermentation yield and profile.**

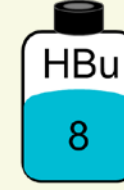
# EXPERIMENTAL DESIGN

## Co-fermentation WAS-FW



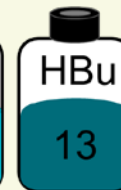
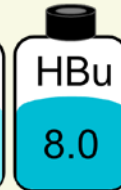
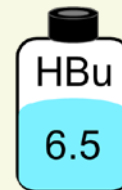
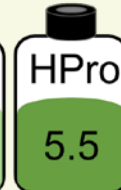
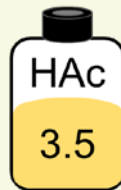
- 1 How does the addition of these three acids affect the fermentation?

Mesophilic  
Anaerobic condition  
70:30 %VS (WAS:FW)  
No pH control



gCOD/L

- 2 Do we get the same response with different concentrations?



gCOD/L

The following parameters were monitored: pH, VFA and XOH concentration\*

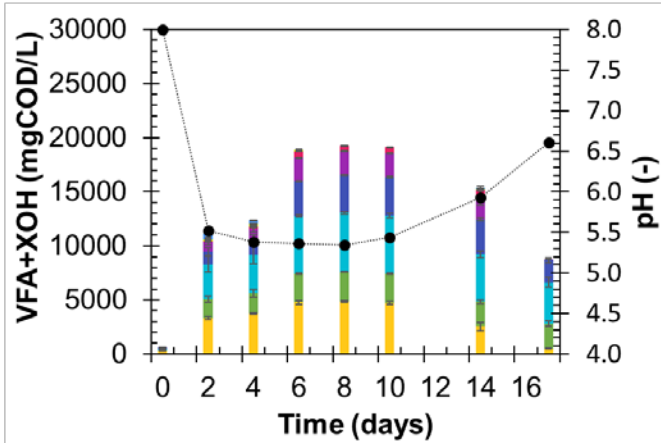
\*APHA, 2017. Standard Methods for the Examination of Water and Wastewater. 23rd edition. American Public Health Association, Washington, DC.

# RESULTS

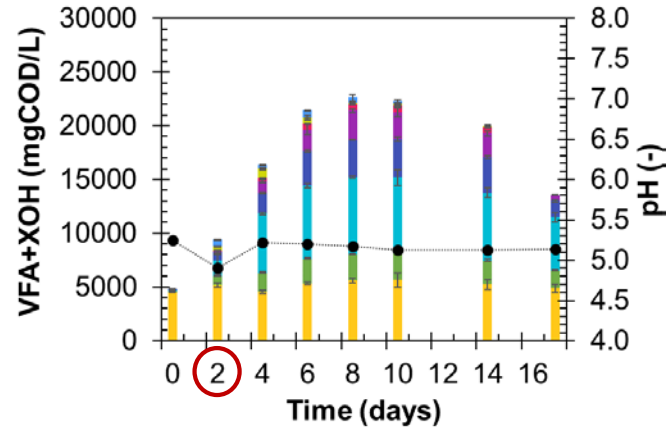
1



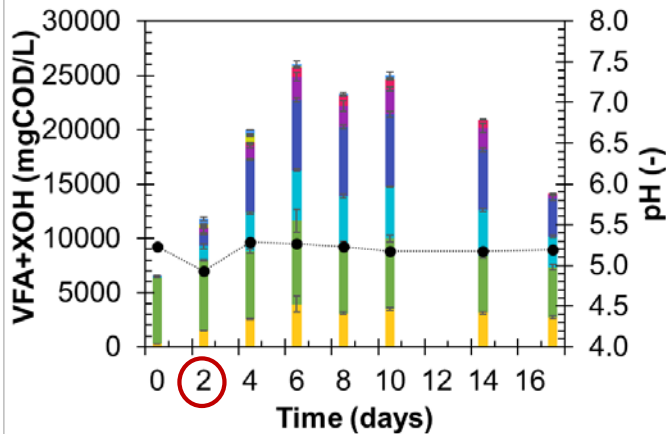
**WAS:FW (Control)**



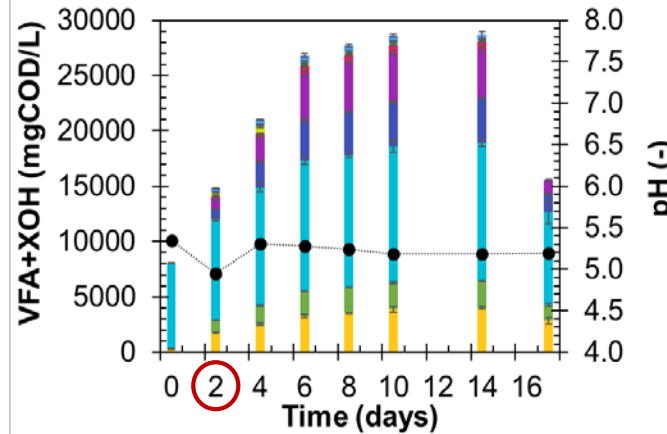
**WAS:FW (6g COD HAc/L)**



**WAS:FW (6g COD HPro/L)**



**WAS:FW (8g COD HBu/L)**



*Total net fermentation products*

	<b>WAS:DF</b>	<b>6g COD HAc/L</b>	<b>6g COD HPro/L</b>	<b>8g COD HBu/L</b>
<b>0</b>	599	599	599	599
<b>2</b>	10436	4178	5014	6837
<b>4</b>	11768	10883	12835	12535
<b>6</b>	18728	15950	19742	18643

- A drop in pH is observed in **day 2** in all condition except the control.
- **Final pH** is the **same** in **all condition** **except** for the **control**
- Also, a **delay** in **acid** creation is observed in **all conditions** when **compared** to the **control**.

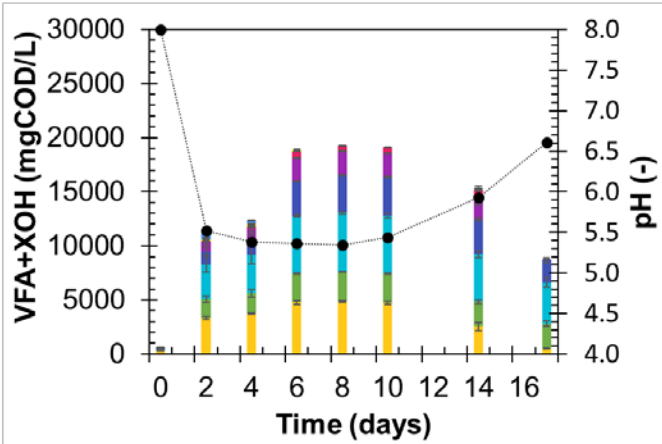
# RESULTS

1

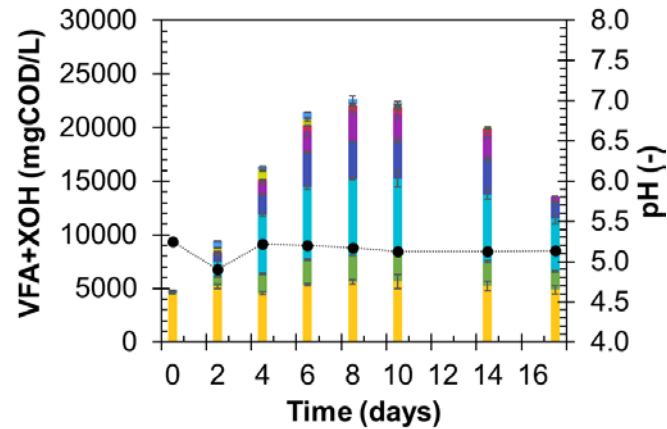


gCOD/L

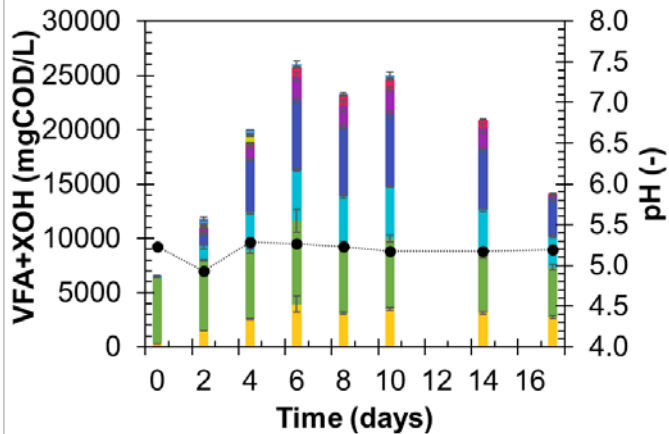
**WAS:FW (Control)**



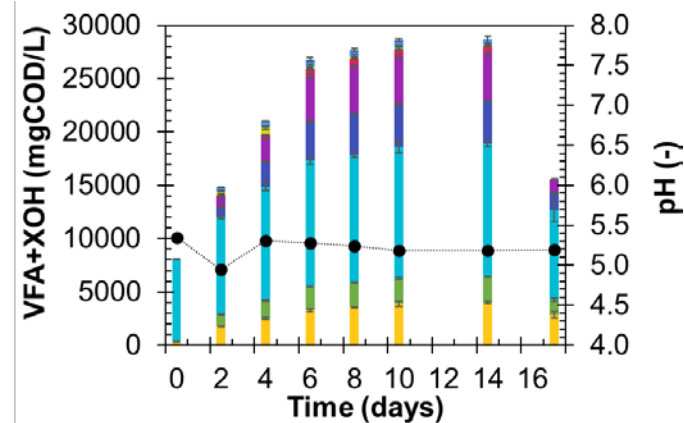
**WAS:FW (6g COD HAc/L)**



**WAS:FW (6g COD HPro/L)**



**WAS:FW (8g COD HBu/L)**



In all conditions where acid was added, an increase in long-chain acids was seen.



**HAc** produce more **HBu**, and less **HPro**  
**HPro** produce more **HVa**, and less **HAc** and **HBu**  
**HBu** produce more **HCa**, and less **HAc** and **HPro**

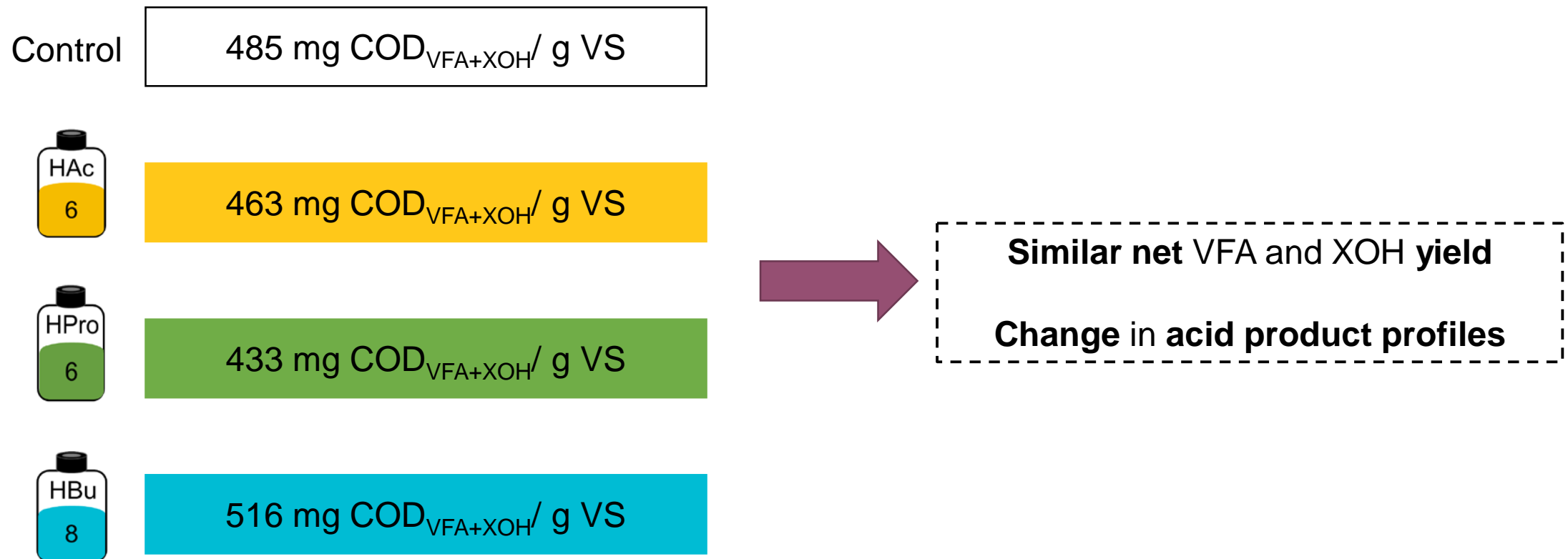
# RESULTS

1

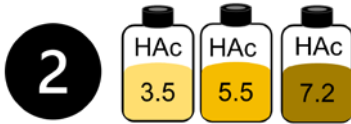


gCOD/L

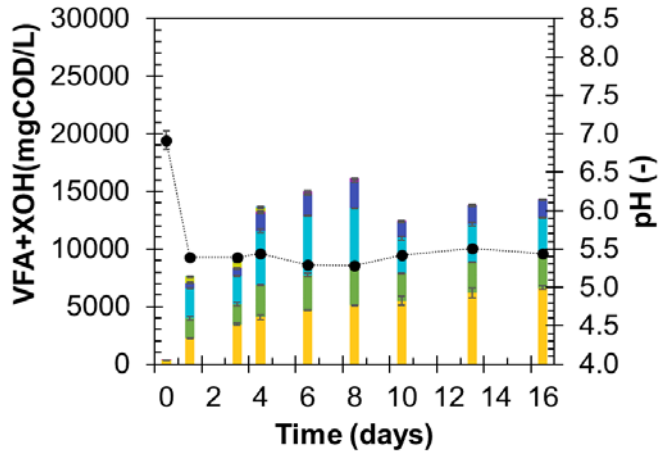
**Fermentation yield at the net maximum VFA and XOH concentration obtained at 8 day**



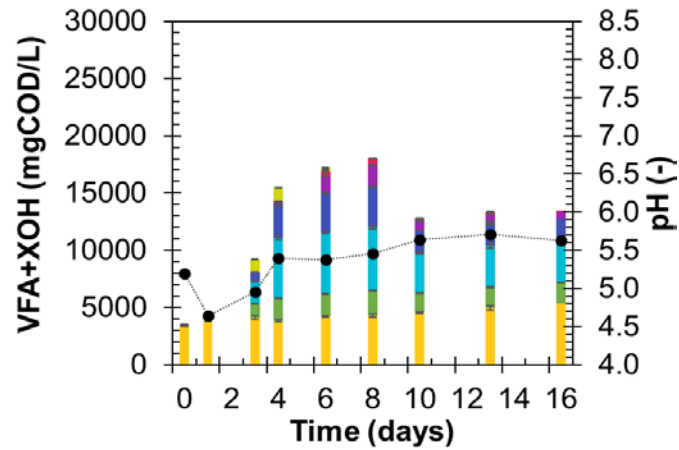
# RESULTS



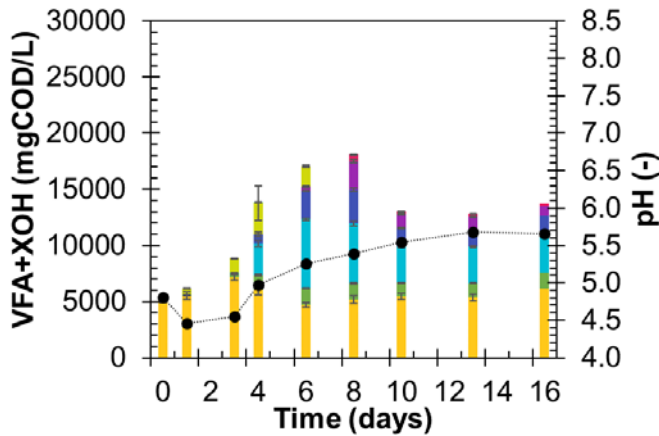
## WAS:FW (Control)



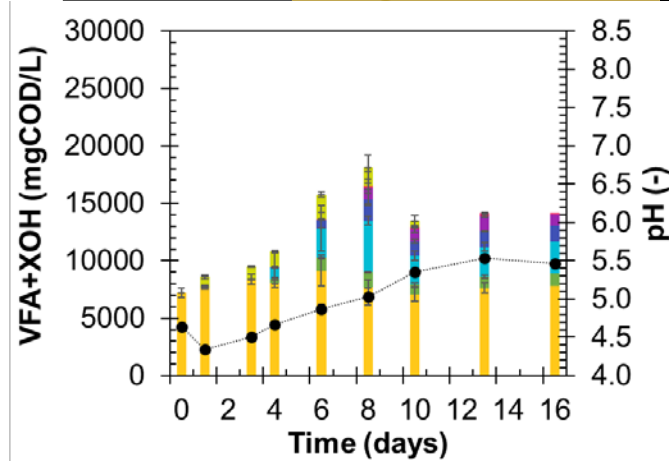
## WAS:FW (3.5 gCOD HAc/L)



## WAS:FW (5.5 gCOD HAc/L)



## WAS:FW (7.2 gCOD HAc/L)

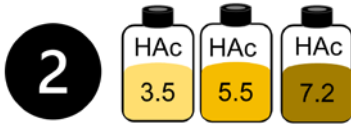


- The higher the acid concentration, the longer the delay in fermentation.
- Final concentration of fermentation products and the pH were the same

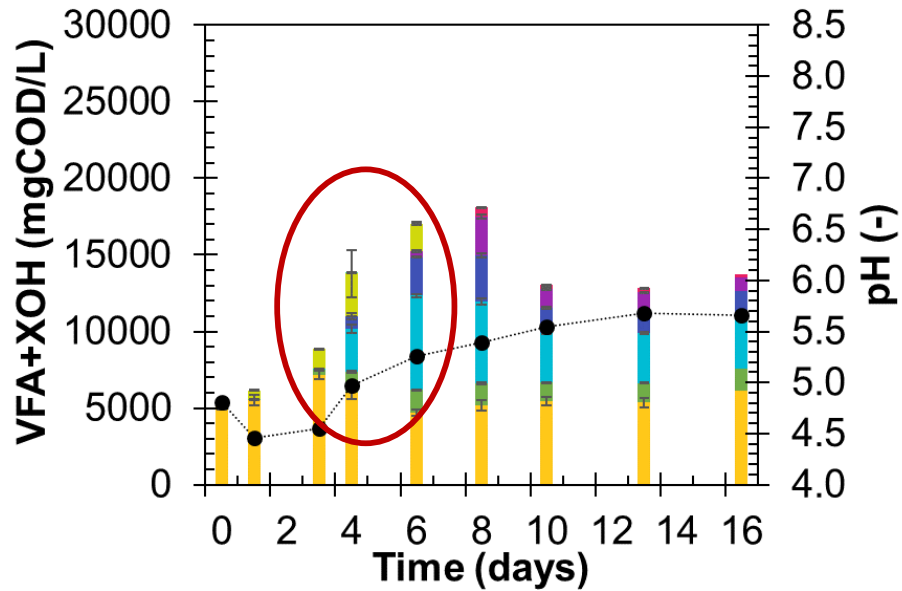
HAc produce more HBu, and less HPro



# RESULTS

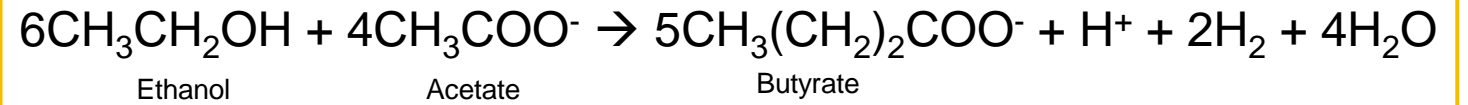


## WAS:FW (5.5 gCOD HAc/L)



- Butanol
- Propanol
- Ethanol
- Heptanoic
- Caproic
- Valeric
- Butyric
- Propionic
- Acetic
- pH

## Possible reaction of Chain elongation



Angenent, et al (2016)

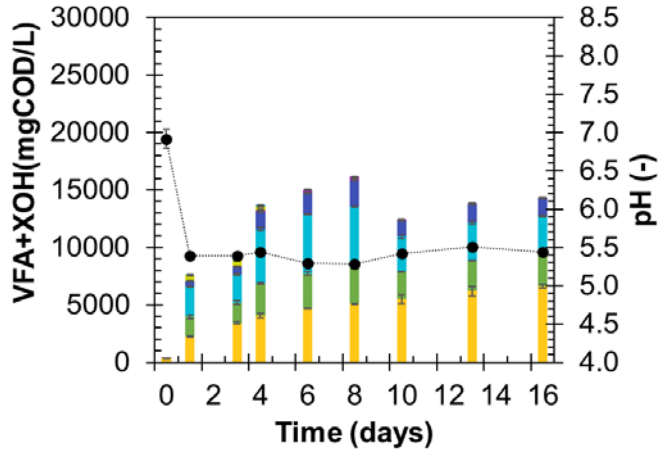
Angenent, et al (2016) <https://doi.org/10.1021/acs.est.5b04847>

# RESULTS

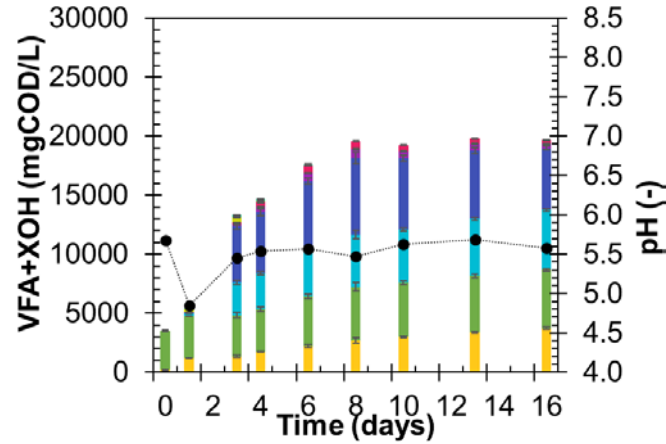
2



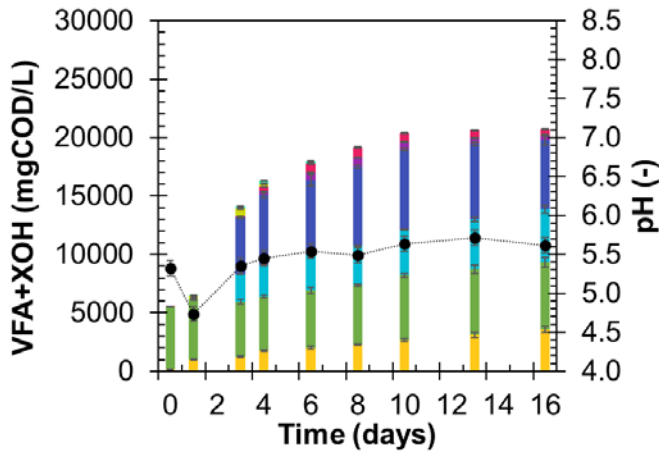
**WAS:FW (Control)**



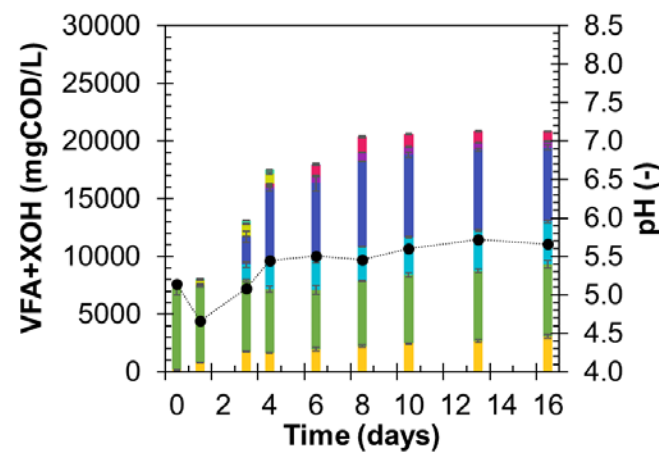
**WAS:FW (3.5 gCOD HPro/L)**



**WAS:FW (5.5 gCOD HPro/L)**



**WAS:FW (7.2 gCOD HPro/L)**



■ Butanol    ■ Propanol    ■ Ethanol    ■ Heptanoic    ■ Caproic  
■ Valeric    ■ Butyric    ■ Propionic    ■ Acetic    ● pH

- The higher the acid concentration, the longer the delay in fermentation.
- Final concentration of fermentation products and the pH were the same

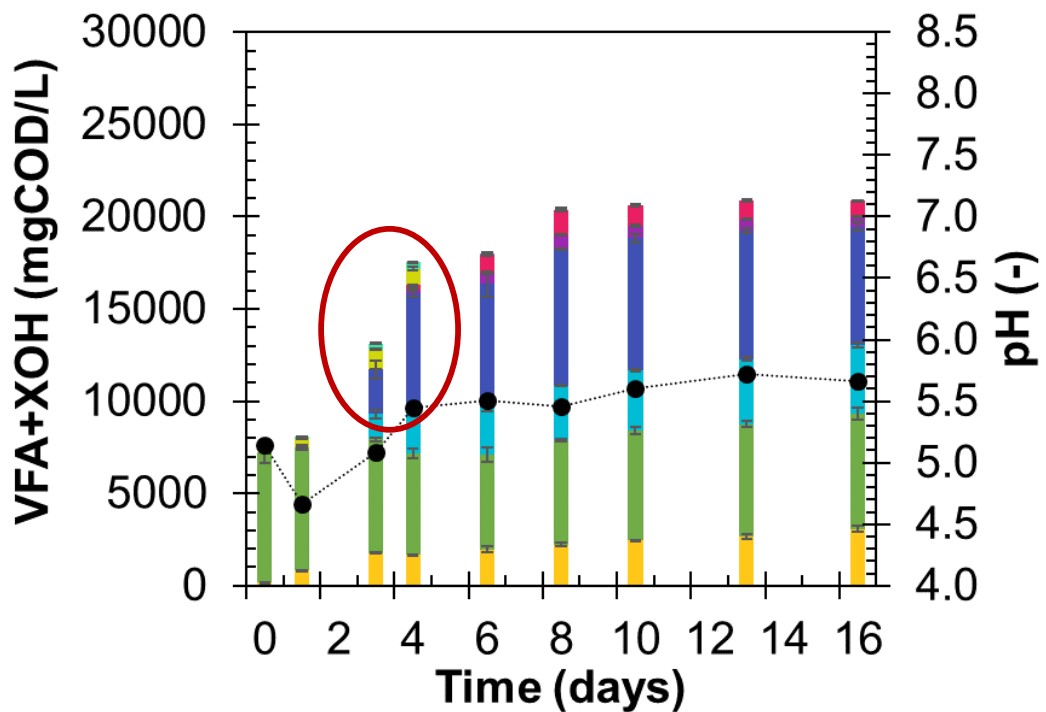
HPro produce more HVa, and less HAc and HBu

# RESULTS

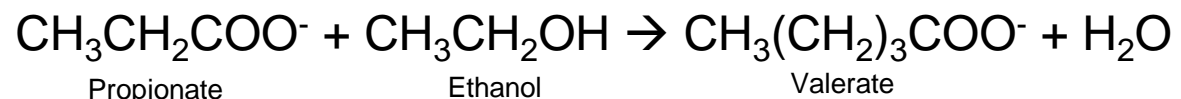
2



## WAS:FW (7.2 gCOD HPro/L)



## Possible reaction of Chain elongation

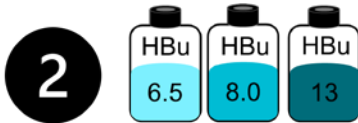


Coma et al. (2016)

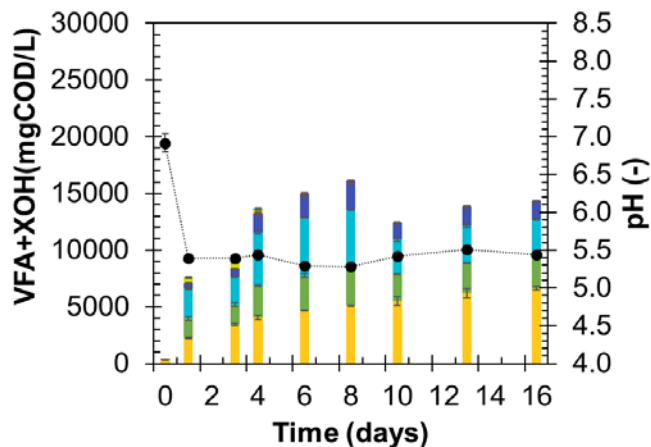
Coma et al (2016) <https://doi.org/10.1021/acs.est.5b06021>



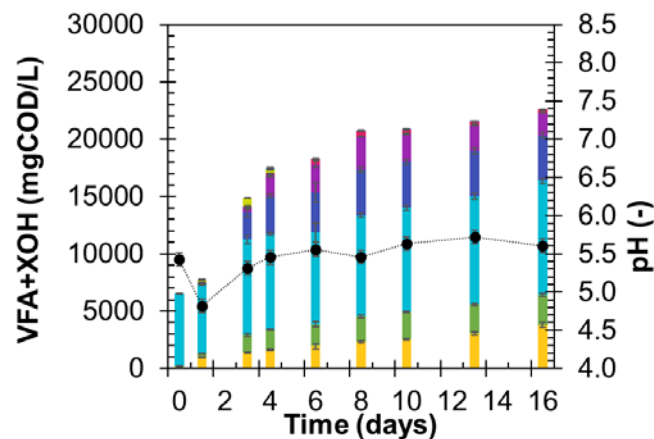
# RESULTS



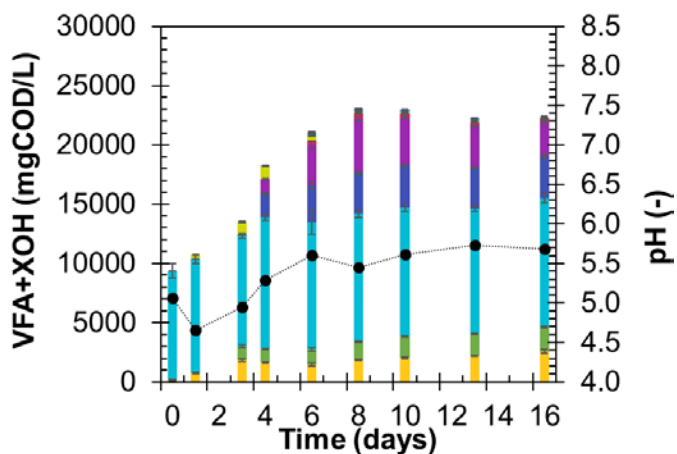
### WAS:FW(Control)



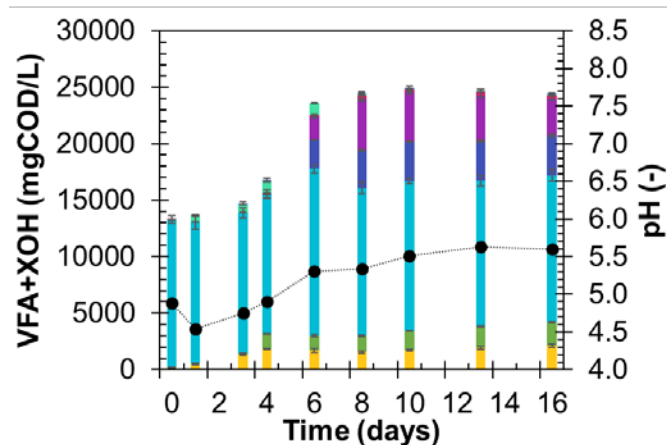
### WAS:FW (6.5 gCOD HBu/L)



### WAS:FW (8.0 gCOD HBu/L)



### WAS:FW (13.0 gCOD HBu/L)



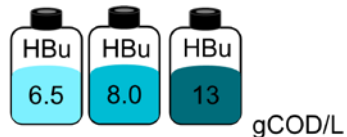
- The higher the acid concentration, the longer the delay in fermentation.
- Final concentration of fermentation products and the pH were the same

HBu produce more HCa, and less HAc and HPro

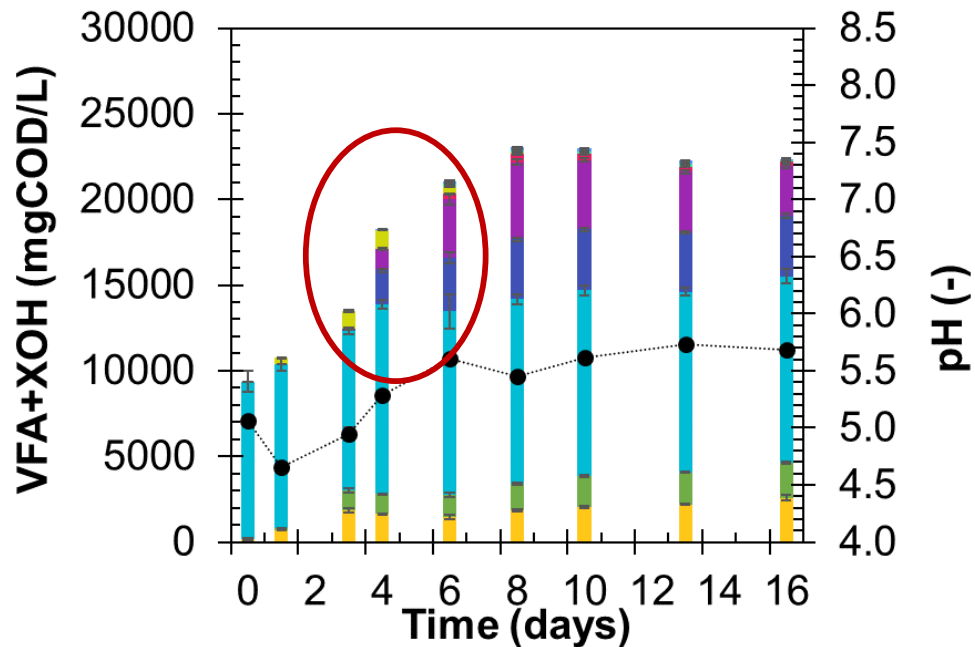


# RESULTS

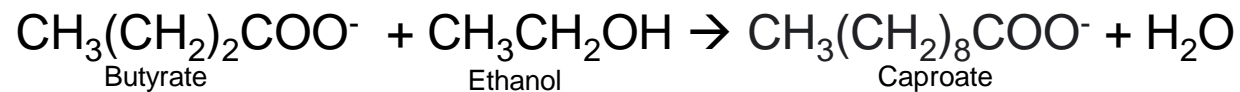
2



## WAS:FW (8.0 gCOD HBu/L)



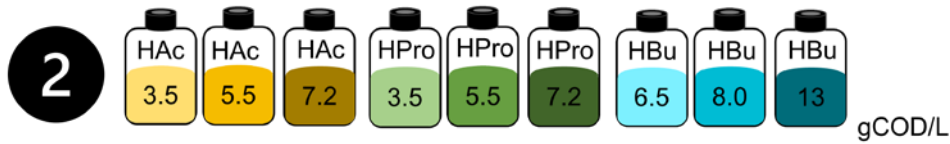
## Possible reaction of Chain elongation



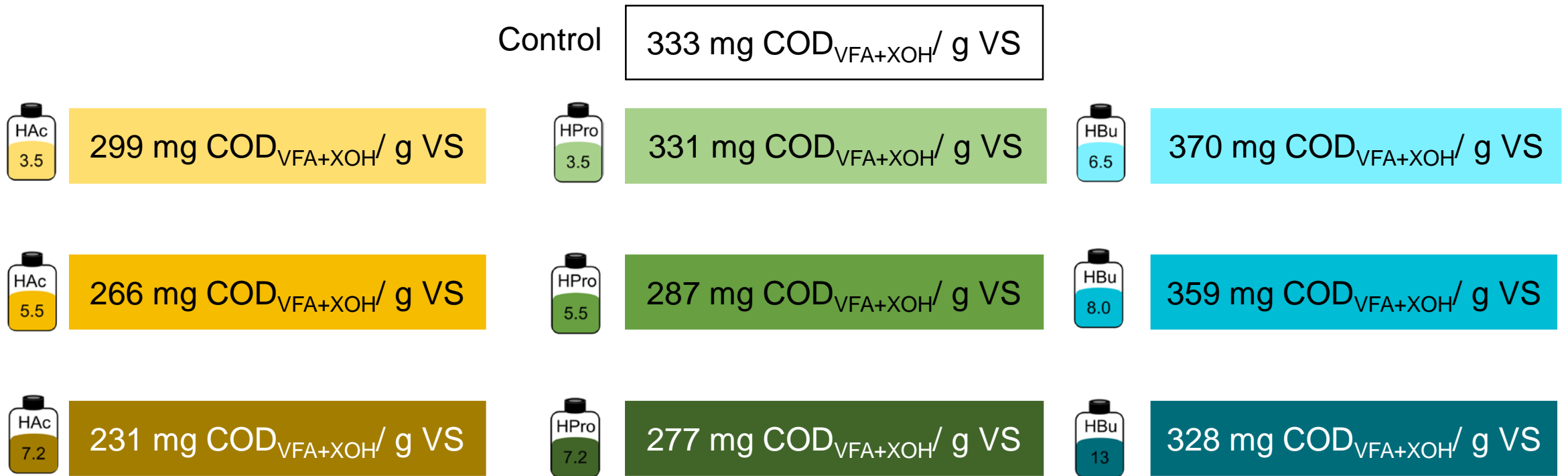
Coma et al. (2016)

Coma et al (2016) <https://doi.org/10.1021/acs.est.5b06021>

# RESULTS




**Fermentation yield at the net maximum VFA and XOH concentration obtained at 8 day**




**Yield decreases with increasing acid addition**  
**Change in acid product profiles**


# CONCLUSIONS




**Delay in VFA and XOH production during the fermentation**




**Delay in VFA and XOH production was related to the added concentration**



**Increasing the concentration of the added acid results in a reduction of the yield.**



**Higher concentration of long-chain VFA, when the acid is added.**



**The long-chain VFA produced depend on the acid added.**



More experiments are needed to explain the production of C5-C6 VFA.

		Added acid		
		HAc	HPro	HBu
VFA Profile	HAc	=	↓	↓
	HPro	↓	=	↓
	HBu	↑	↓	=
	HVa	↑	↑	↑
	HCa	↑	↑	↑



Environmental Biotechnology group



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Thank you very much!



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