Acidogenic co-fermentation of Waste Activated Sludge and Glycerol at different pH control conditions to tune the volatile fatty acids profile

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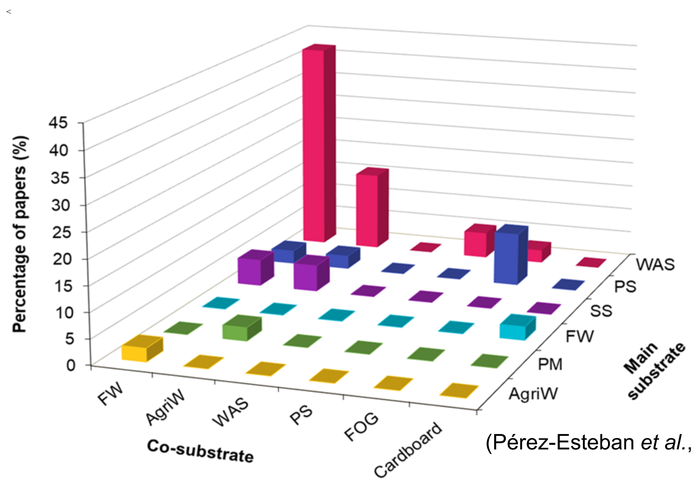
1 - Introduction

Volatile fatty acis (VFAs) are platform chemicals with a growing market demand in chemical, environmental and pharmaceutical applications.

The production of **biobased VFAs from Waste Activated Sludge (WAS)** is an opportunity to transform wastewater treatment plants into biorefineries. **Acidogenic co-fermentation** with other substrates could lead to increased VFA production.

WAS is an ideal main substrate for co-fermentation using as cosubstrate (Pérez-Esteban *et al.*, 2022):

(i) highly biodegradable organic waste with limited (or no) alkalinity
(ii) Organic waste that cannot self-sustain a microbial community
(iii) Organic Waste with low moisture content



(Pérez-Esteban *et al.*, 2022)

Figure 1. Main substrates and co-substrates in publications dealing with acidogenic co-fermentation (AgriW: agro-industrial waste, FOG: fats, oils and greases, FW: food waste, PS: primary sludge, PW: paper waste, WAS: Waste Activated Sludge)

2 - Objective

This study is focused on the evaluation of **WAS + Glycerol Acidogenic co-fermentation**:

- **Short-term effect of pH** on VFA production and profile with and without methanogens inhibition (BES, 2-bromoethanesulfate)
- **Long-term effect of the working pH on semi-continuous fermenters operation**

3 – Materials and Methods

Batch assays: Several working conditions were tested in batch assays by triplicate (see Table 1) at mesophilic conditions using WAS (2 collection periods). The fermentation relied on the indigenous microbial community of WAS

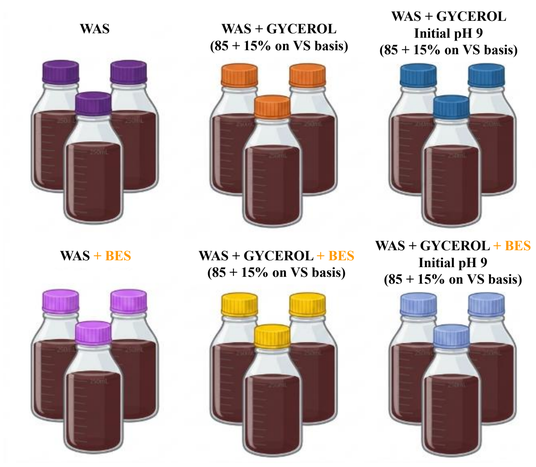
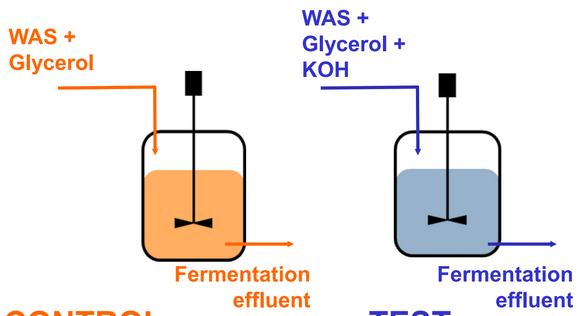


Table 1. Experimental conditions carried out in batch assays

Working conditions	Description
WAS	Control
WAS + BES	
WAS + Glycerol	Co-fermentation without pH control
WAS + Glycerol + BES	
WAS + Glycerol + KOH	Co-fermentation with initial pH control at 9
WAS + Glycerol + KOH + BES	

Long-term operation: 2 Semi-continuous fermenters (4L) were operated at mesophilic conditions with and without KOH addition during 46 days:



Parameter	Control fermenter	Test fermenter
pH of the feed	6,5 - 7	9
Temperature (°C)	37	
HRT (days)	3,5	
OLR (g COD/(L day))	11.6	

Analytical Methods: Standard Methods for the Examination of Water and Wastewater

4 – Results and discussion

Figure 2 and 3 shows that **batch co-fermentation of WAS with glycerol** consistently increased VFA production compared to WAS mono-fermentation, thus confirming the synergistic effect of the combined treatment. BES addition effectively suppressed methanogenesis. The condition WAS + Glycerol (initial pH 9) leads to the highest VFA yield, although methanogenic activity appeared when BES was not added.

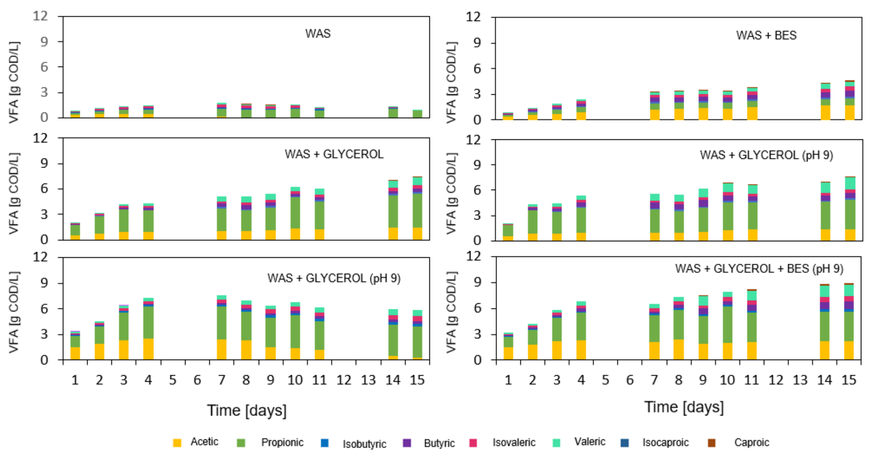


Figure 2. VFA production for WAS collection period 1

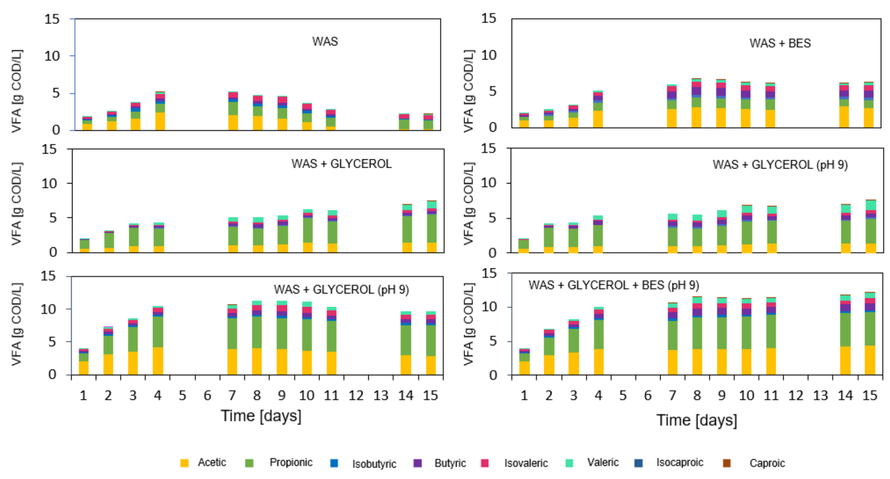


Figure 3. VFA production for WAS collection period 2

Figure 4 summarises the VFA concentration of the feed and the fermentation effluent of both semi-continuous fermenters. Stable VFA production over time was observed in both fermenters, thus confirming BES was not required under long-term conditions to avoid methanogens proliferation when working at an HRT of 3.5 days.

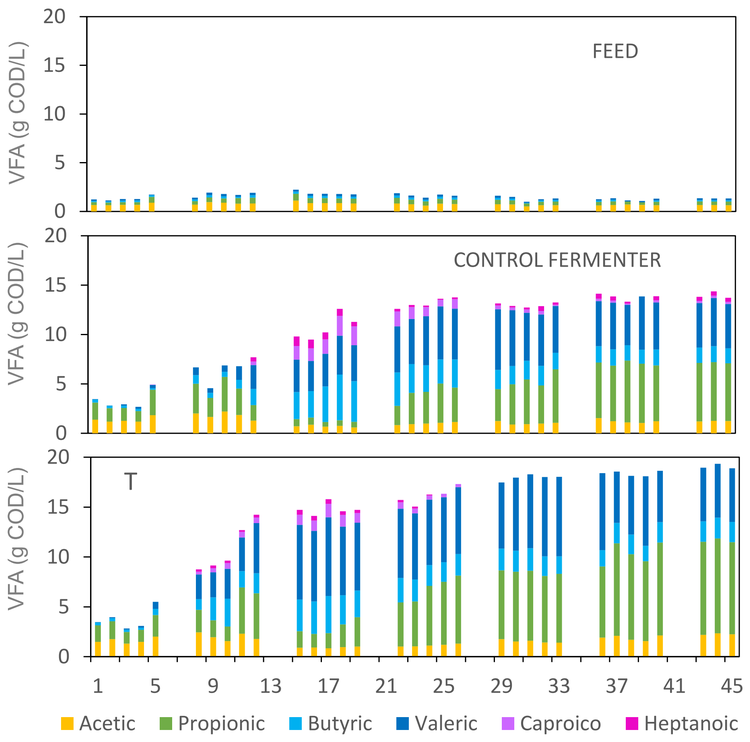


Figure 4. VFA concentration in the feed and the fermentation effluents of the semi-continuous acidogenic fermention processes.

Fermentation effluents were enriched in propionic and valeric acids. A ~47% increase in VFA yield and a higher acidification degree (0.82) were monitored when the pH of the feed was set at alkaline conditions (Table 3), which is attributed to a higher biomass activity until reaching a final pH around 5.

Table 3. VFA yield and acidification degree of the Control and Test fermenters.

Parameter	Control fermenter	Test fermenter
VFA Yield (g sCOD/ g tCOD)	0.36 ± 0.01	0.53 ± 0.01
Degree of acidification (-)	0.60 ± 0.20	0.82 ± 0.01

5 – Conclusion

Acidogenic co-fermentation of WAS and glycerol lead to a fermentation effluent enriched in propionic acid. When the pH of the WAS+Glycerol mixture fed was controlled to 9, higher VFA yields and acidification degrees were recorded, thus indicating the relevance of the working pH in acidogenic co-fermentation units. Under the tested operational conditions, methanogenesis was prevented in both fermenters.

Reference:

Perez-Esteban et al. (2022) *Sci. Total Environ.* 813, 152498

Acknowledgments

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