IDENTIFYING AND QUANTIFYING PHA IN BIOMASS

Correlation between PHBV monomers and VFAs to scale up the production

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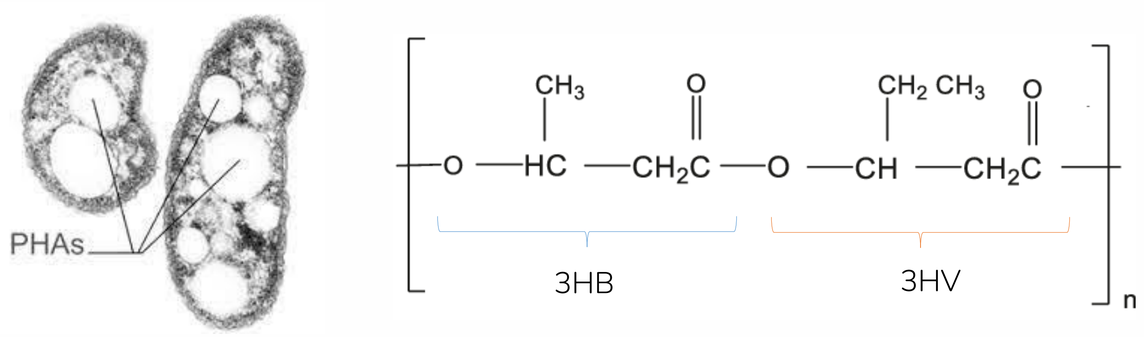
Introduction

Polyhydroxyalkanoates (PHA) are a family of biopolyesters that are produce by bacteria. Mixed culture biomass usually produces PHBV and its properties can be controlled by adjusting the feed given to the bacteria, the volatile fatty acid-rich waste stream (VFAs).

PHBV is the most promising biopolymer for petroleum-based plastic replacement, since it has the advantages of plastic, but not the disadvantages, being completely biodegradable, light and moldable.

a b

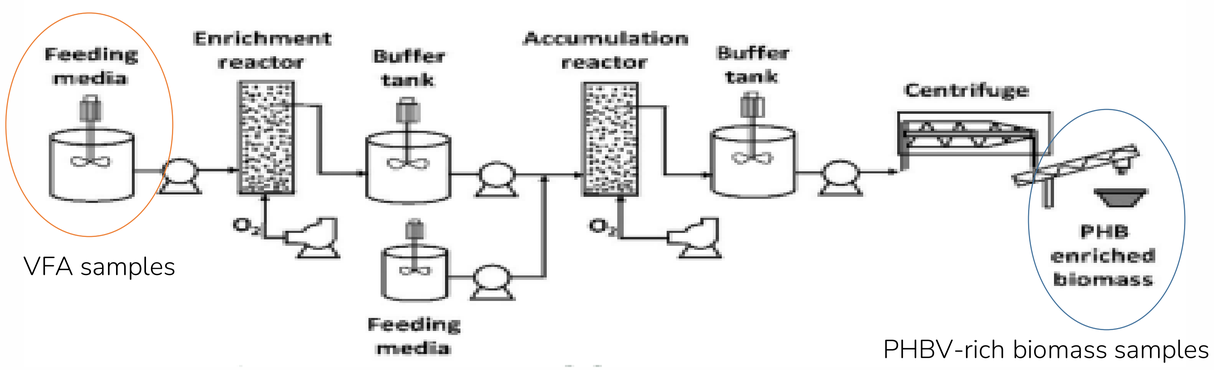


Bacteria with PHA inside (a) and Structure of PHBV (b)

Goal of Research

- Investigate the correlation between VFAs and the production of PHBV.
- Provide data to scale up the production of PHA from demo plant to industrial scale.

Methods



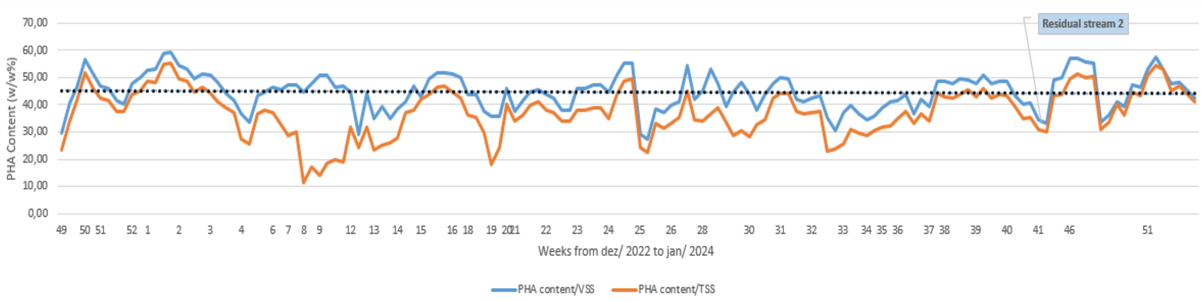
PHA-rich biomass production flowchart.

Gas Chromatography (GC): determine PHBV content and 3HB and 3HV concentrations.
Thermogravimetry (TGA): determine biomass composition, including PHBV content.
Ion Chromatography (IC): determine the VFAs concentration in the feed.

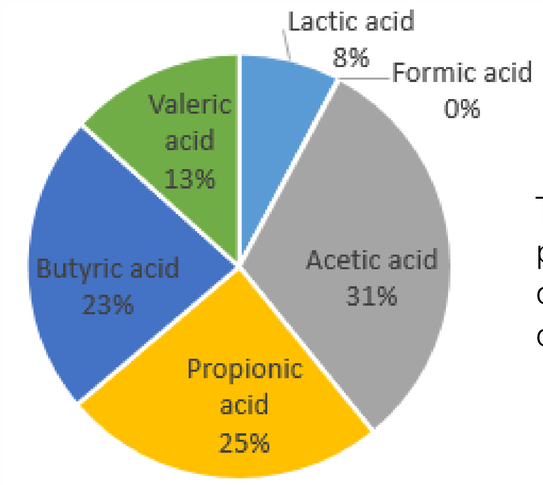
Results/Discussion

- Influence of the concentration of VFAs on the amount of PHBV produced

Average = 44,7 w/w% PHBV/VSS



Concentration of PHBV/VSS and PHBV/TSS over time.

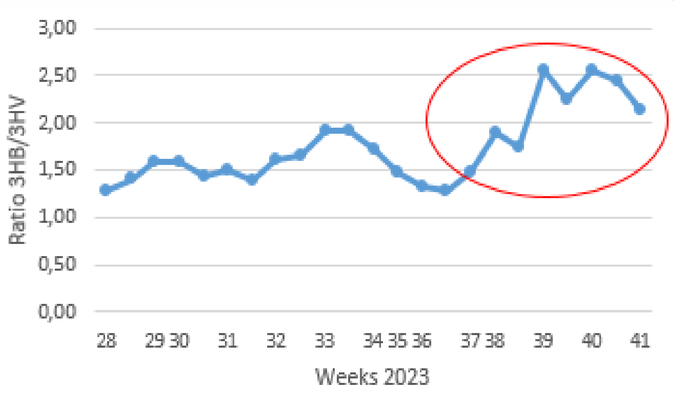


Average of VFAs in the feed during the weeks

The concentration of PHBV/VSS produced in the demo plant proved to be constant despite the great variation in the concentration of VFAs during the weeks.

- Influence of the concentration of VFAs on the quality of the PHBV produced

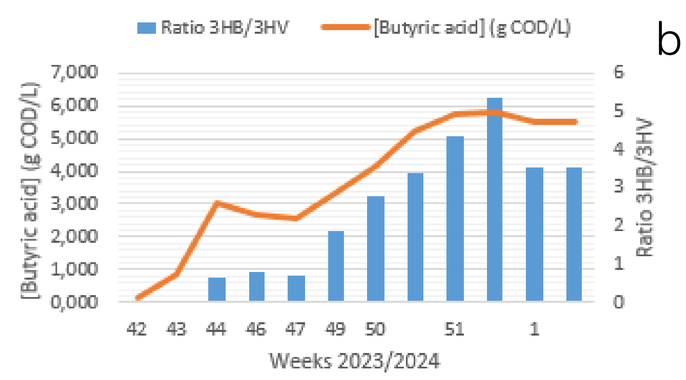
a



From week 37 to 41 of 2023, synthetic feed (acetic acid + propionic acid) was used. There was an increase in the 3HB/3HV ratio during this period.

When residual stream 2 began to be used as substrate, the concentration of butyric acid increased considerably and the 3HB/3HV ratio accompanied this increase.

b



3HB/3HV ratio from week 24 to week 41 of 2023 (a) and 3HB/3HV ratio compared to butyric acid concentration (g COD/L) from week 42 of 2023 to week 01 of 2024 (b).

Higher concentrations of even carbons, as acetic acid and butyric acid, can lead to increased formation of 3HB (Tao et al., 2022; Cai et al., 2022). The consequence is a higher 3HB/3HV ratio, which affects the PHBV quality.

Conclusion

VFA profile of residual stream 1 is different from residual stream 2. The most important difference is the butyric acid increase in the second one, which affects the monomer composition and by consequence the PHBV quality. However, the 2 different residual streams produced the same amount of w/w% PHBV/VSS.

Modifications in the PHA production process (enrichment, accumulation, etc.) have a greater impact on the quantity of PHBV produced in the demo plant than the concentration of VFAs.

References

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