PRODUCTION OF VOLATILE FATTY ACIDS FROM STARCH WASTE

Through an Optimized process of anaerobic fermentation in a semi-continuous mode

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Introduction

The valorization of residues from the food industry into volatile fatty acids (VFA) presents a sustainable approach to waste management and resource efficiency. VFAs are essential building blocks for producing value-added chemicals, and biopolymers like PHA or PLA [1]. Anaerobic digestion offers an eco-friendly method to convert starch waste into high-value compounds addressing both environmental pollution and the reliance on synthetic materials. This research aimed to optimize VFA production from starch waste through anaerobic fermentation of starch waste in a semi-continuous mode to evaluate a stable and controlled production process. This will be further used for the stable production of PHA.

Methodology

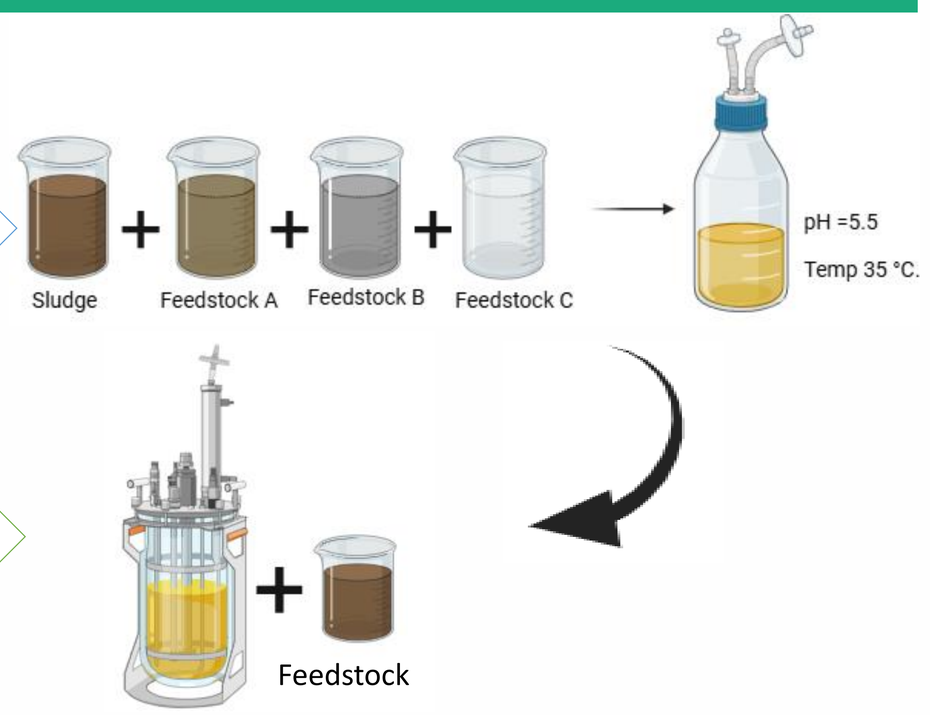
The approach that was taken in this research was the following;

Inoculum Preparation

- Prepared to produce the bacteria that will be used for the bioreactor experiments
- Contained Feedstock A Feedstock B Feedstock C and sludge in a ratio of 1: 4 in virtue of ¼ volume of sludge and ¾ volume of feedstocks (100ml of feedstock A+100 ml of feedstock B+100 ml of feedstock C)

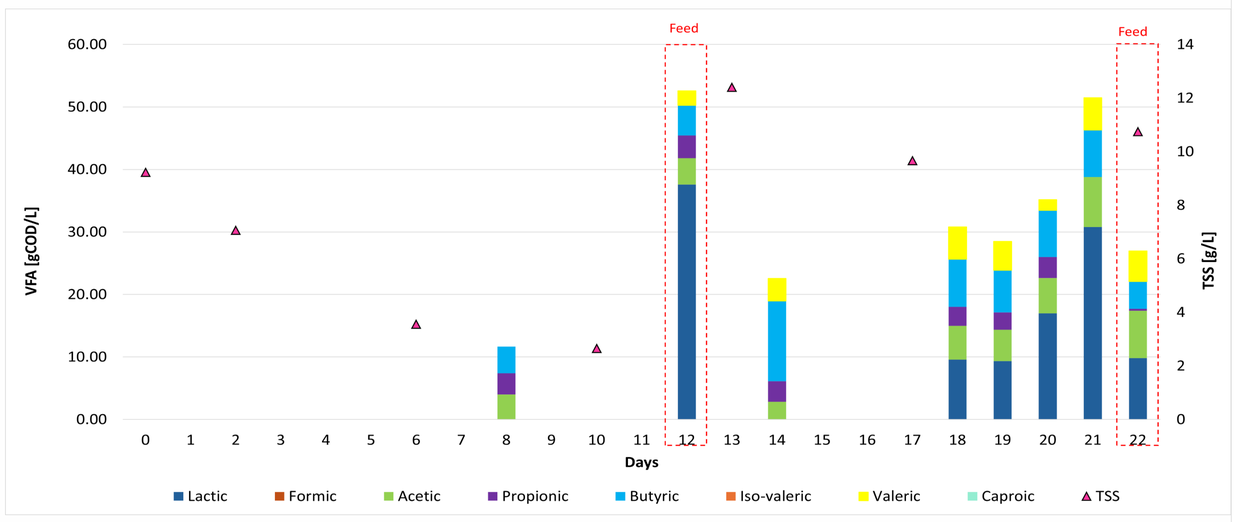
Bioreactor Experiment

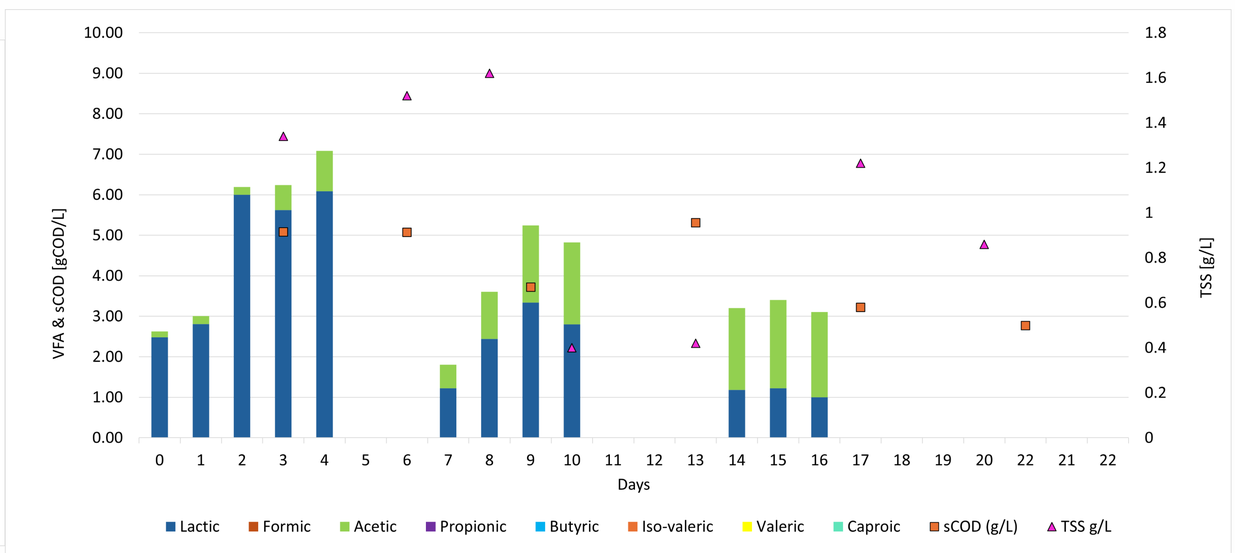
- Optimal parameters observed in the earlier phase of the project were assessed in 4 2.5L bioreactors for three weeks in each reactor
- Feedstock A operated at 35˚C with uncontrolled pH
- Feedstock A operated at 35˚C with pH 5.5
- Feedstock B will be operated at 35 ˚C with pH 5.5
- Feedstock C will be operated at 35 ˚C with pH 5.5



Results

The analysis of VFAs from the Inoculum (left graph) demonstrated significant production, with lactic acid being the dominant acid , followed by valeric, butyric and acetic acids. This indicates that the inoculum effectively goes through anaerobic digestion during the fermentation as confirmed by the successful hydrolysis rate observed in the total suspended solids (TSS) analysis. On the other hand, the graph on the right illustrates the results of the uncontrolled pH fermentation of feedstock 1, which produced lactic and acetic acids in a 3:1 ratio. These acids are suitable for the production of biomaterials like bioplastics [3]. Interestingly, while the inoculum produced a broader variety of VFA's the individual feedstock produced only two types of acids.





Advice & Recomendations

Literature research [2] revealed that starch waste has a good potential to produce a wide range of VFA including lactic, acetic, and propionic acids which can be used for their diverse applications. This was confirmed through the anaerobic fermentation of starch waste which yielded 50 g/L COD of VFAs from the semi-continuous fermentation process. Nevertheless, acetic and lactic acid were the only acids produced. Additionally, these acids can be applied separately as cleaning agents, food preservatives, pesticides, or PLA production.

Past research done in the earlier phase of the project revealed that at 35 ˚C temperature and pH 5.5 will result in an optimized fermentation process nevertheless the uncontrolled pH process obtained a similar VFA yield reducing the amount of chemicals for pH regulation. The results revealed that the process produced only lactic and acetic acid. The soluble COD decreased over time indicating possible loss of VFAs from day 7 of the semi-continuous process. Furthermore, the conclusions cannot be completely assessed because the VFA composition is still under analysis. Therefore, the result was not optimal for VFA production. It is recommended that if the same streams have to be used for PHA production the process needs to be further optimized.

References

1. H. Al Battashi *et al*, "Polyhydroxyalkanoate (PHA) Production Using Volatile Fatty Acids Derived from the Anaerobic Digestion of starch Waste."
2. P. Elefsiniotis, D. G. Wareham and M. O. Smith, "Effect of a starch-rich industrial wastewater on the acid-phase anaerobic digestion process," *Water Environ Res,* vol. 77, *(4),* pp. 366–371, 2005.
3. Nasser A. Al-Tayyara , Ahmed M. Youssefb,∗ , Rashad Al-hindi, "Antimicrobial food packaging based on sustainable bio-based packaging reducing foodborn pathogens," *Science Direct,* 2020