Model Development of VFA Production Using Starch Waste Feedstock

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Introduction

Volatile fatty acids (VFAs) are produced in anaerobic digestion fermentation. VFAs are used as building blocks for PHA bioplastics.

This project uses a starch-based feedstock (figure 1) to produce VFAs. An efficient VFA production depends on optimal process functioning conditions for converting residual feedstocks.

The aim of this project is to validate a prediction model, find out which optimal temperature, pH, and retention time (HRT) would be suitable for producing VFAs using the starch-based feedstock mixed mictobial cultures (MMCs).

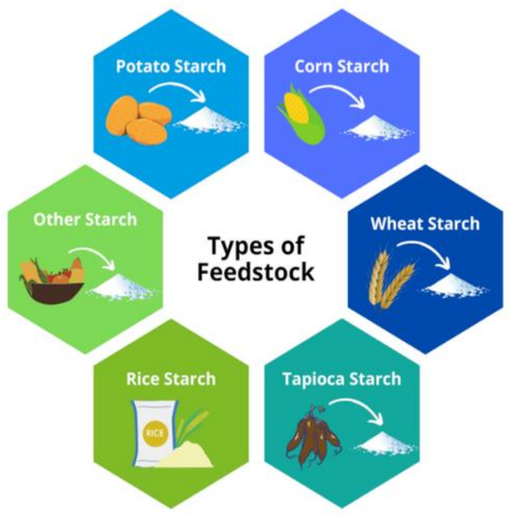

Figure 1: Example starch-based feedstocks [1]

Methodology

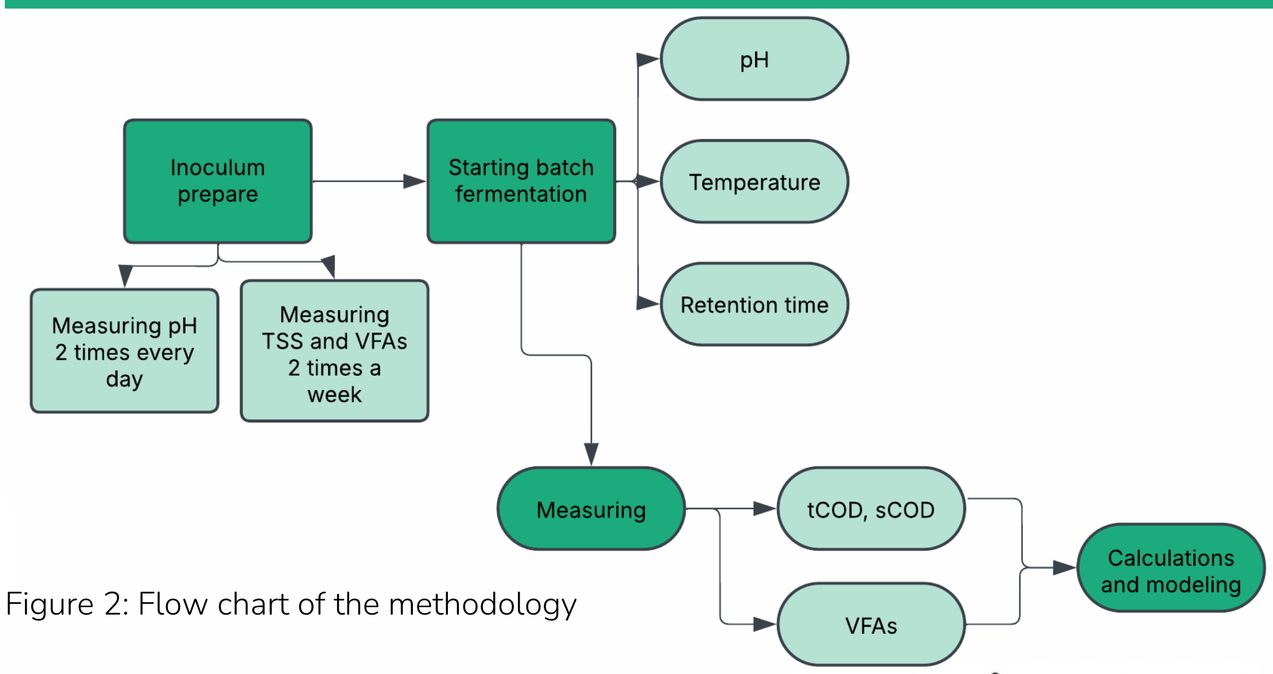

Figure 2: Flow chart of the methodology

Using DoE (figure 3) 17 different designs were tested, the first day and last day of the fermentation process samples were taken to measure VFAs (using HPLC) and the sCOD. With these results the program MODDE 13.1 was used to make the model.

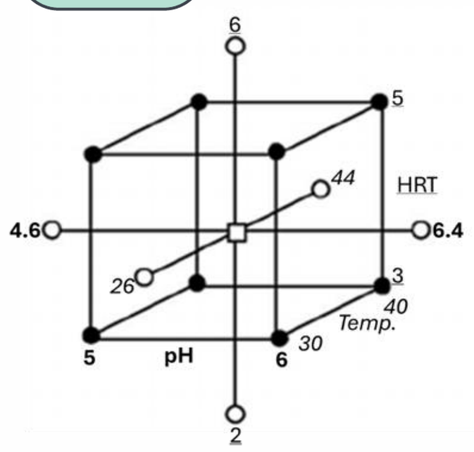

Figure 3: Design of experiments (DoE) with temperature, pH, and HRT

Results and Discussion

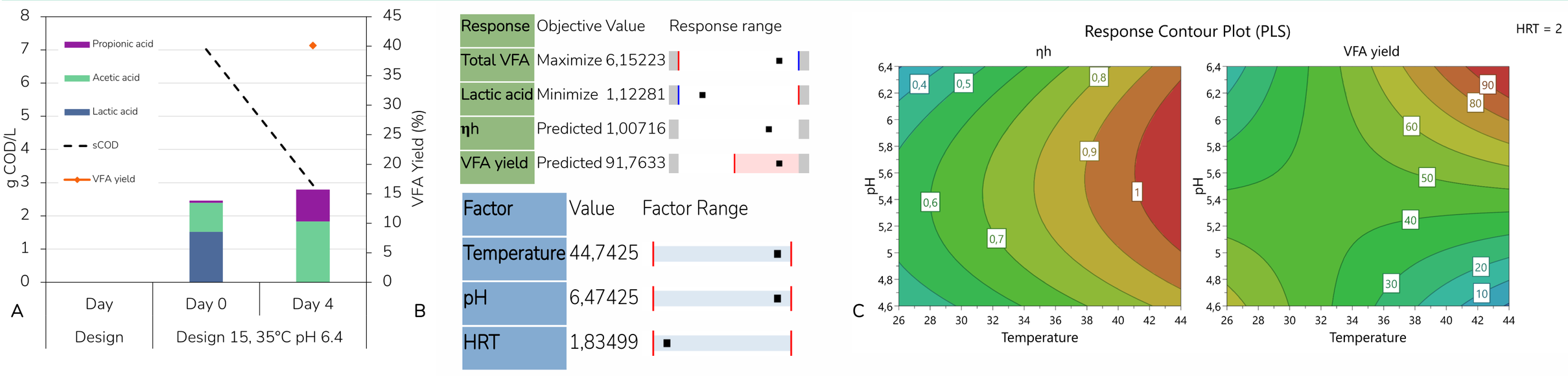

Figure 3: A; VFA production, sCOD and VFA yield of Design 15, B; Predictions of best conditions for VFA production with the starch-based feedstock, C; MODDE response contour plot using ηh (sCODout/sCODin) and VFA yield (% VFApro/(tCODi feed - VFAi))

In figure 3A lactic acid is consumed or converted, the acetic and propionic acid are produced because of the high pH. For all 17 designs the ηh (unconverted sCOD) and VFA yield was calculated and fit to the model. Figure 3B represents the optimized prediction of parameters when the desired output of the process are selected (e.g. min lactic acid concentration). The max VFA yield of 91.7% was then predicted. Figure 3C shows the fit model as a heat map in red the highest production and in blue the lowest.

Conclusion

According to literature starch-based feedstock produce acetic, propionic, and butyric acids [2]. In this work, only acetic and propionic acids were produced. For this feedstock, the predicted optimal conditions for VFA production is at high temperature 45°C, pH 6,5. Literature showed that a higher HRT are favorable for anaerobic digestion of starch-based feedstock [3], in this work low HRT (2 days) would boost the production and is more cost effective. In this work a model was developed and validated to improve the reliability for the process enabling a better business case for industry.

Acknowledgements

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References

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3. C. Hong and W. Haiyun (19 March 2010), Bioresource Technology