The role of hydrothermal treatment on the production of VFAs for bioplastics: Assessment of extraction methods

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Introduction

Conventionally, the production of bioplastics incorporates the utilization of biomass that has the capacity for PHA production. Feast and Famine cycles exerted on Mixed Microbial Cultures (MMCs) can result in improved production of Polyhydroxyalkanoates (PHAs) bioplastics. In principle, volatile fatty acids (VFAs) are produced during the anaerobic digestion (AD) of biomass and are utilized for feeding the MMCs. In the framework of this study two novelties are presented. Hydrothermal treatment is utilized as an alternative - and in this case thermochemical-pathway to AD for faster production of VFAs. In addition, two different extraction techniques, liquid-liquid and ultrasonic assisted liquid-liquid, were used to extract VFAs from wastewater samples.

Methods

Cheese whey wastewater was treated in a 4570A Parr hydrothermal reactor with a temperature range from 120 to 180 °C and evolved autogenous pressures. The hydrothermal products were sampled in 30, 60 and 120 minutes respectively. Extraction of the VFAs from the samples was performed with two methods: liquid-liquid and ultrasonic assisted liquid-liquid extraction, while the selected solvent was Diethyl Ether. The identification of the produced VFAs was implemented using an Agilent 6891 GC-FID instrument with a wax column DB-WAXETR 30m x 0.53mm x 1µm.

References

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Results and Discussion

- Hydrothermal treatment produced primarily butyric acid and isovaleric acid. Secondarily, also acetic and propionic acids were identified.
- Butyric acid concentration increased when residence time increased during hydrothermal treatment and ranged between 3200 and 4000 ppm.
- On the other hand, the concentration of isovaleric acid fluctuated between 500 and 1000 ppm but the concentration profile was affected significantly by the temperature of hydrothermal treatment.
- Overall, ultrasonic assisted liquid-liquid extraction gave better results for VFAs separation from cheese whey wastewater samples

Fig.1. Parr Hydrothermal Reactor

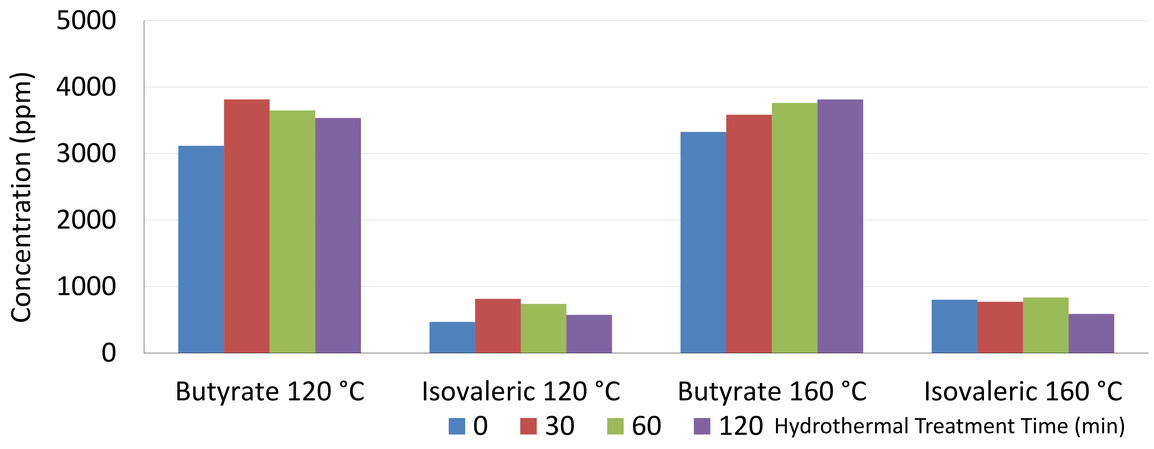

Fig.2. Effect of temperature and treatment time on VFAs production during hydrothermal treatment (sample: Cheese Whey Wastewater)

Future Prospects

- Qualitative analysis by means of Nile red
- Repeat bioplastics production and verify bioplastic production via GC analysis.
- Measurement of VFAs consumption with GC
- Ammonia measurement to calculate mixed crop growth

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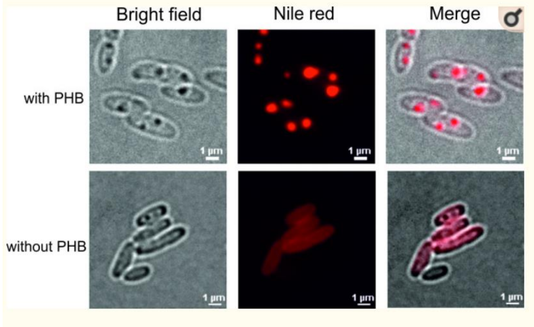

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Figure 7.
Fluorescence micrographs of cells with and without PHB.
From left to right: bright field, Nile red, merged channels of bright field and Nile red. Upper panel: cells with PHB granules, Lower panel: cells without PHB granules.

Fig.3. Determination of PHB (Juengert, 2018)