

CONTINUOUS IN SITU LACTIC ACID EXTRACTION FROM SWEET WHEY FERMENTATION BROTH USING A TUBULAR MEMBRANE CONTACTOR

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Background

Whey, as the major dairy by-product, has become a severe problem for the dairy industry because its demand has decreased, while its production has increased in the past years. Since the high demand for dairy products tends to further increase, suitable routes for whey valorization are required. Whey contains valuables like lactate, but due its composition matrix, processing is challenging.

The high sugar content in whey makes it a potential feedstock to produce lactic acid (LA) via microbial fermentation. Still, the known drawbacks of biotechnological LA production, such as growth inhibition by the product, the use of neutralizers, low productivity, and high overall costs of the process must be overcome. *In situ* LA recovering using a suitable separation technology is a potential strategy to overcome the mentioned drawbacks.

In this work, the *in situ* LA extraction from a whey fermentation broth was evaluated. Sweet whey was used as feedstock for lactic acid production via microbial fermentation, while LA was recovered by reactive liquid-liquid extraction using a tubular membrane contactor.

Method

The feed material used in this work is a fermentation broth from sweet whey, which was filtered prior to extraction experiments using microfiltration. In a first series of experiments, two-phase extraction experiments were conducted in temperature controlled separation funnels, to investigate different solvent phase combinations for the lactic acid extraction. Special attention was paid to replace commonly applied fossil-based solvents with green alternatives, such as deep eutectic solvents (DES). After extraction, the extract was treated in a back-extraction step to recover LA from the solvent phase. Here, an anti-solvent, e.g. heptane or *p*-cymene, was used to transfer LA to the receiving phase, which was water.

Afterwards the performance of reactive liquid-liquid extraction of LA using a PTFE membrane contactor was evaluated by using two potential solvent phases, namely tri-*n*-octyl amine (TOA) with *n*-decanol and a DES formed from thymol and menthol. From the experimental results the overall mass transfer coefficient was calculated based on a rigorous mass transfer model to predict the LA concentration in both phases. Finally, performance of the *in situ* LA recovery from sweet whey by using membrane contactor was investigated from both, experimentally and theoretically points of view.

Results & Conclusion

In the two-phase extraction experiments, the reactive extractants Aliquat336, TOA, trioctylphosphinoxid (TOPO), and the mixture Aliquat336/TOA were found to be most efficient with the diluents 1-decanol, limonene, and a deep eutectic solvent consisting of thymol and menthol. Especially, the DES and limonene are promising as they can be produced from

renewable resources. With respect to back-extraction, heptane and *p*-cymene showed the highest efficiencies for transferring lactic acid into the receiving phase water.

In the next step, the selected solvents were used to perform LA recovery in the tubular membrane contactor from a model aqueous solution of LA and a fermentation broth of sweet whey. The proposed technology for valorizing dairy waste through LA biotechnological production shows the feasibility to scaling it up.