The potential of electrotechnologies for enhancing the efficiency of precision fermentation processes

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In food and bio technology, proteins are increasingly produced in microbiological production systems, by means of fermentation. In conventional bioprocesses, downstream processing is usually initiated by cell disintegration, using high-pressure homogenization. This step is followed by extensive purification steps due to the resulting high loads of host cell impurities.
In order to reduce impurities of the resulting protein solutions, pulsed electric field (PEF) treatment and the resulting electroporation was investigated for permeabilization of cell membranes and the selective release of target proteins from *E. coli*. For this purpose, continuous electroporation was employed to selectively extract recombinant Protein A from the periplasm of *E. coli*. For this purpose, a specifically designed flow-through PEF treatment chamber was deployed, operated at 1.5 kg/h, using rectangular pulses of 3 ms at specific energy input levels between 10.3 and 241.9 kJ/kg. Energy input was controlled by variation of the electric field strength (28.4–44.8 kV/cm) and pulse repetition frequency (50–1000 Hz). The effects of the process parameters on cell viability, product release, and host cell protein (HCP), DNA, as well as endotoxin (ET) loads were investigated.
It was found that a maximum product release of 89 % was achieved with increasing energy input levels. Cell death also gradually increased, with a maximum inactivation of -0.9 log at 241.9 kJ/kg. The conditions resulting in high release efficiencies while keeping impurities low were electric field strengths ? 30 kV/cm and frequencies ? 825 Hz. In comparison with high-pressure homogenization, PEF treatment resulted in 40% less HCP load, 96% less DNA load, and 43% less ET load.
Therefore, PEF treatment can be an efficient alternative to the cell disintegration processes commonly used in downstream processing. Ultimately, PEF can contribute to design continuous or circular, more efficient bioprocesses for future applications in food and bio technology.