PRODUCTION OF MEDIUM CHAIN FATTY ACIDS FROM GRASS

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Lignocellulosic biomass such as grass can serve as a renewable carbon source for chemical production such as lactic acid. Lactic acid can be converted to caproic acid via microbial chain elongation, which can be used as precursor for fuel production. To investigate the feasibility of this approach, grass was pre-treated and fermented to lactic acid. The fermentation effluent containing lactic acid was fed to a subsequent reactor for chain elongation to produce caproic acid. Membrane electrolysis extracted and concentrated the caproic acid to a concentration above its solubility in water for phase-separation recovery from the solution.

Grass was harvested from grassland, grinded and fermented in a semi-batch operation at 32 °C to produce lactic acid under non-sterilized, mixed culture and pH un-controlled condition. The fermentation effluent was subsequently used to produce caproic acid through chain elongation in another reactor. The broth containing caproic acid was sent through an electrochemical system with an anion exchange membrane, in which an applied current extracted and concentrated the caproic acid. The highest rate of caproic acid production was tested by retaining the cells with centrifugation. Maximum concentration of caproic acid production was investigated by adding 20 g/L of sodium lactate per day to the elongation broth.

Carboxylates were produced semi-continuously from pre-treated grass at a rate of 4 g lactate/kg grass dry matter (DM) per hour and yield of 15 % grass DM to lactate conversion. The lactic acid concentration stabilized at 9.36 ± 0.95 g/L, which was limited due to reactor design. In the subsequent elongation reactor, the highest rate of caproate production achieved was 0.99 ± 0.02 g/L/h, when the cells were retained in during semi-continuous elongation operation. The caproic acid concentration stabilized at 4.09 ± 0.54 g/L, these titres are normal considering the as-yet low input concentrations of lactate. The highest concentration of caproic acid achieved was 10.9 ± 0.6 g/L under excess sodium lactate. An in-situ extraction system is important in these processes to improve the production rate and conversion.

Here, we provide the first proof of concept that grass can be used to produce caproic acid, through chain elongation of lactic acid, directly in the fluid originating from the lactic acid fermentation. The caproic acid can be extracted, concentrated and phase-separated in an electrochemical system. This can give rise to a better carbon source utilization and yield a more attractive balance on process economics.

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