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Direct fermentation of food waste in continuous flow culture

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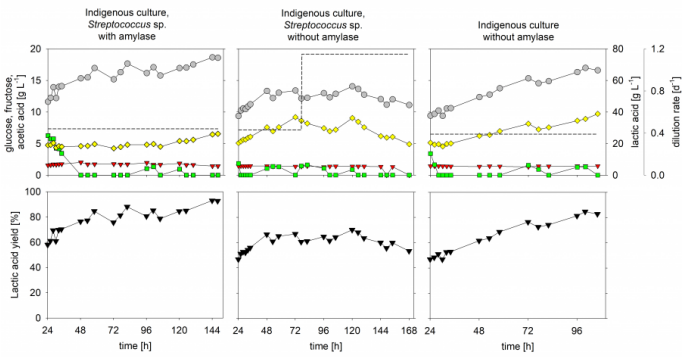
PURPOSE OF THE ABSTRACT
This study investigated non-sterile lactic acid fermentation with batch and continuous flow cultures. Un-pretreated highly viscous food waste served as substrate. Even during continuous mode no dilution was conducted. Fermentation was carried out with Streptococcus sp. and an indigenous culture without addition of external nitrogen or carbon sources. Performance of different microbial communities and food waste collections was compared with regard to lactic acid titer, yield, and productivity. Furthermore the effect of amylase addition was tested. In batch experiments, best results were obtained with addition of amylase to the indigenous community. Here, titer, productivity and yield were 50 g L-1, 63%, and 2.08 g L-1 h-1, respectively. Without amylase, 38 g L-1, 47 %, and 1.58 g L-1 h-1 could be produced. Complementing the indigenous community with Streptococcus sp. did not enhance performance.

During continuous runs, both titer and yield were increased, while productivity was lower. When the indigenous community was supplemented with Streptococcus sp. and amylase, values of 74 g L-1, 93 %, and 1.19 g L-1 h-1 could be attained after 148 h running time at a dilution rate of 0.44 d-1. Similarly, when fermenting only with the indigenous community, titer, productivity, and yield amounted to 65 g L-1, 85 %, and 0.90 g L-1 h-1 after 96 hours at a dilution rate of 0.39 d-1.

On the basis of experimental results, economic and energy evaluation was carried out. Scenarios were adapted to plants with 50,000 to 1,000,000 people in the catchment area of the facility. For both batch and continuous cultures, profitable scenarios could be identified starting from 200,000 people in the catchment area. Even though amylase addition is a costly step in the overall process, most economic profit could be gained from batch scenarios with amylase present. Continuous scenarios, on the other hand, were only profitable without external enzyme.

Overall, it could be shown that direct fermentation of only mechanically pretreated food waste is feasible leading to efficient utilization of the substrate. Through techno-economic assessment, applicability to industrial scale is indicated.

FIGURES



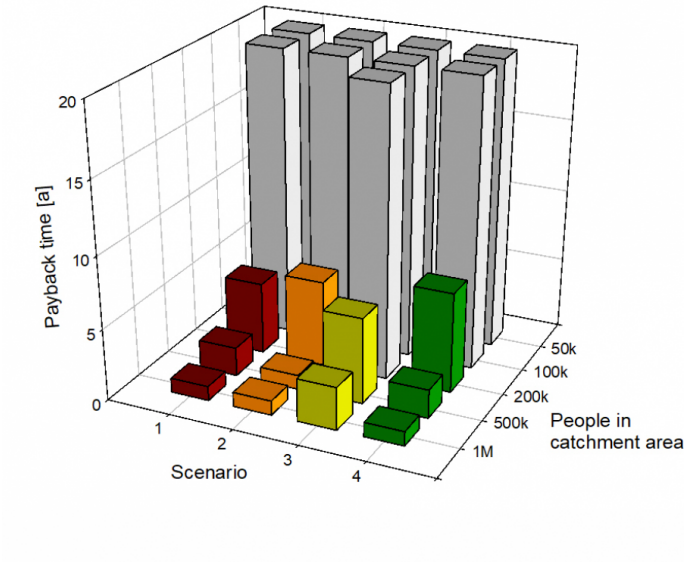


FIGURE 1

Non-sterile food waste fermentation

Continuous flow cultures after 24 hours of batch operation at 35 °C and pH 6. Concentration of glucose (trianlge), fructose (square), acetic acid (diamond), lactic acid (circle). Dilution rate (dashed line).

FIGURE 2

Payback time for continuous food waste treatment plant

1 Indigenous communitiy (IC), Streptococcus sp. (Ss), and amylase; dilution rate (DR): 0.44 d-1;
2 IC and Ss, DR: 0.43 d-1;
3 IC and Ss, DR: 1.15 d-1;
4 IC, DR: 0.39 d-1.
Grey bars indicate payback time exceeding plant lifetime.

KEYWORDS

Continuous flow culture | Food waste | Non-sterile fermentation | Lactic acid

BIBLIOGRAPHY