RETASTE Conference Abstracts
Vol. 3 RETASTE-NOV-511-Poster
Athens, Greece, 27-29 September, 2023

rethink food resources, losses, and waste 2023 retaste

Optimizing Lactic Acid Production from Potato Fermentation: Effects of Inoculum-to-Substrate Ratio and Organic Acid By-products.

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Abstract

Potatoes have formed the foundation of diet in Central Europe and are one of the main components of food waste in the region. This study investigated the influence of different inoculum-to-substrate ratios (ISRs) on lactic acid fermentation utilizing potatoes as the sole (pure) substrate. The objective was to evaluate how varying inoculum levels could affect the synthesis of both lactic acid and other organic acids. A mixed culture of anaerobic digester from a municipal wastewater treatment plant was employed as process biomass, and five ISRs (1:1, 1:2, 1:4, 1:6, 1:8) were tested with different substrate loading rate. The fermentation process was conducted under controlled conditions, including agitation at 100 rpm, a pH ranged from 5 to 6, and a temperature of 35 °C. Periodic sampling was performed to measure the concentrations of organic acids. The findings demonstrated that the ISR significantly influenced lactic acid production. Higher ISRs (1:6, 1:8) resulted in increased lactic acid synthesis compared to lower ratios (1:1, 1:2, and 1:4). Notably, the study revealed a positive correlation between the ISR and lactic acid concentration, with the highest concentration observed at an ISR of 1:6, reaching 87 g/L. However, at the ISR of 1:8, the concentration of L-lactic acid decreased to 75 g/L, primarily due to an elevated concentration of D-lactic acid, whereas, the highest L-Lactic acid concentration recorded at ISR 1:1, 1:2, 1:4 are 6 g/L, 9 g/L and 23 g/L. The higher concentration of D-lactic acid at an ISR of 1:8 suggests that this ratio may have a distinct effect on the microbial composition and metabolic pathways. This shift towards D-lactic acid production may be attributed to the presence of specific microorganisms or metabolic pathways that promote its synthesis. Additionally, a higher substrate quantity relative to the inoculum biomass created a less favourable growth environment for lactic acid bacteria, contributing to the decrease in lactic acid concentration at the ISR of 1:8. In addition to lactic acid, the fermentation process yielded various other organic acids, whose concentrations were also influenced by the ISR. These results underscored the impact of initial levels of the inoculum biomass on the

microbial composition and metabolic pathways involved in fermentation. Overall, this study emphasized the importance of optimizing the ISR for lactic acid fermentation using potatoes as a substrate. Higher ratios were found to enhance lactic acid production, although the ISR of 1:8 led to a decrease in lactic acid concentration and an increase in D-lactic acid concentration. These findings highlight the significance of considering an appropriate ratio to maximize lactic acid production, regulate fermentation processes, and modulate the concentration and isomeric composition of the resulting products. Industrial applications can benefit from these findings by optimizing lactic acid production and effectively managing the fermentation process.

Keywords: Food waste; Lactic acid, Inoculum-to-substrate ratio, Organic acid; Valuable product recovery