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Anaerobic digestion of organic fraction combinations from food waste, for an optimal dynamic release of biogas, using H_2 as an indicator

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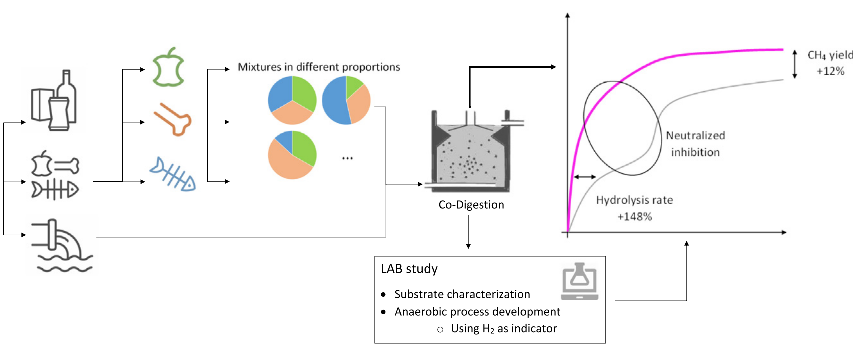
HIGHLIGHTS

- Agrifood waste can be considered as a mixture of three elemental organic fractions.
- Organic combinations contribute to the dynamics of anaerobic biogas and CH_4 release.
- The optimal combination of elemental fractions is given in a ratio of 1:1:1.
- H_2 monitors inhibition, neutralization and methanogenesis reinforcement.
- An optimal mix raises hydrogenotrophic methanogenesis a 12 % and speeds it up a 148 %.

GRAPHICAL ABSTRACT



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ABSTRACT

The objective of this study is to assess the effects of mixing the three elemental organic waste fractions (fruit and vegetable, meat, and fish) during anaerobic digestion. Batch experiments were carried out with fraction mixtures of different proportions. The results were compared, concerning the single digestion of each fraction, the gas generation, and the process performance, using H_2 as an indicator. It was determined that the optimal mixture was the one with the fractions in equal proportion. This mixture achieved a balanced composition, a faster process by 58 %, and a 12 % increase in methane production. It was also determined that, as a rule, mixtures increase the hydrolysis speed and that the meat fraction mixtures manage to make this substrate suitable for anaerobic treatment by increasing the rate of hydrolysis by 148 % and buffering the acidification inhibition that suffers in its single digestion.

1. Introduction

Renewable gases, such as biogas, are part of the solution to achieve climate neutrality by 2050 (IEA, 2020) when contributing to emissions reduction, the penetration of renewable energies and boosting the circular economy (Quintana-Najera et al., 2022). Biogas generation capacity through anaerobic digestion (AD) has been increasing by 4 % per year since 2010 (IEA, 2020), and its immediate activation in the market is desired, looking for sectors suitable for its generation. The agri-food sector is ideal for implementing biogas generation from its waste, both for the waste characteristics (Morales-Polo and Cledera-Castro, 2016) and the amount generated (Jin et al., 2021). It is estimated that around 100 million tonnes of food waste

Abbreviations: AD, Anaerobic digestion; AN, Amoniacal nitrogen; BD, Level of biodegradation; BMP, Biochemical methane potential; coAD, Anaerobic co-digestion; COD, Chemical oxygen demand; CV, Coefficient of variation; FSC, Food supply chain; FW, Food waste; GS, Granular sludge; Hum, Humidity; IA, Intermediate alkalinity; LCFA, Long chain fatty acid; LPCH, Lipids, proteins and carbohydrates content; OM, Organic matter; ON, Organic nitrogen; PA, Partial alkalinity; S, Sludge; Sol, Solubility coefficient; TA, Total alkalinity; TKN, Total Kjeldahl Nitrogen; TS, Total solids; V, M and F, Vegetable, meat and fish residue/fraction; VFA, Volatile fatty acid; VS, Volatile solid; WSM, Wholesale market; WWTP, Wastewater treatment plant.

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