High-solid fermentation and/or anaerobic digestion of solid waste

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Anaerobic biotechnology treatment solutions are considered nowadays an optimal approach for waste valorization and multi-product recovery. Particularly, the anaerobic digestion (AD) process is a well-established technology yielding a mixture of gases, mainly methane (CH_4) and carbon dioxide (CO_2), known as biogas and a solid by-product with potential applications as a soil amendment. Similarly, the dark fermentation (DF) process aims to recover hydrogen as a valuable energy driver and some other intermediates with different applications in the industry as, for example, some polyhydroxyalkanoates (PHA) for bio-plastic synthesis. In short, the DF process could be considered as an 'incomplete' AD where the bio-methanization stage is disregarded and, therefore, both processes share some background characteristics and might be studied together.

In this line, the high-solid content AD and/or DF show many advantages within industrial applications as, for example, a smaller reactor size, a lower need for water addition and the reduction on end-product de-watering strategies. However, recent research on those anaerobic processes has established that the total solids (TS) content plays a crucial role on the biochemistry of the system. In short, it has been proposed that, as the TS concentration increases, the reduction of transport processes (i.e. advection-diffusion) affects both the kinetics and physical aspects of the biological processes. The reason seems related with the low water availability in the system. Thus, the water content is essential for the biochemistry of the system as it promotes hydrolysis and enables the transfer of intermediates and nutrients to the microorganisms.

With all the above, the objective of this project is to investigate the biochemical pathways and kinetics of high-solid anaerobic treatment processes with the aim to optimize the reactors operation and maximize the process rates. To this aim, the understanding of TS kinetics inhibition in the system is crucial, and the development of a mathematical model for high-solid fermentation and anaerobic digestion might aid to optimize the operational conditions for high-solid reactors. On the other hand, the identification of those mechanisms explaining the anaerobic microbial processes at the micro-scale seems compulsory. Thus, the implementation of molecular tools (i.e. qPCR, CE-SSCP, etc.) might help to discern about the main drivers and principal effects of the TS content upon the bio-chemical matrix.

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