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Resum de Tesi Doctoral

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Títol de la tesi: **Study of methods for the improvement of the anaerobic digestion of lipids and long chain fatty acids**

Unitat estructural: **Departament d'Enginyeria Agroalimentària i Biotecnologia**

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(Mínim 1 i màxim 4, podeu veure els codis a http://doctorat.upc.edu/gestio-academica/impresos/tesi-matricula-i-diposit/codis-unesco)

Resum de la tesi de 4000 caràcters màxim (si supera els 4000 es tallarà automàticament)

Anaerobic digestion is a versatile technology platform that transforms, in a biochemical process, diverse categories of biomass feedstock and organic waste to renewable energy, in the form of methane, and contributes to resources conservation and greenhouse gases emission mitigation. Lipid-rich waste and wastewaters have a high energy potential, however efficient methane recovery with conventional anaerobic digestion technology is not easy to achieve because of a wide assortment of operational problems mainly related to the accumulation of long chain fatty acids (LCFA), products of lipids hydrolysis, in the system. The objective of the present dissertation is to test and to evaluate new methodologies and strategies to improve the anaerobic digestion of high-strength lipid waste.

In a preliminary approach, the suitability and the attractiveness of high-strength lipid wastes and slaughterhouse wastes for biogas production was confirmed, suffice to control the applied organic load. The obtained results reinforced the existing knowledge describing the flotation and wash-out of substrate/biomass and the inhibition phenomena affecting the microbial population, as the main process drawbacks. The results of studies submitting anaerobic reactors to increasing concentrations of lipids/LCFA underlined the importance of the adsorption of LCFA onto the microbial cell membrane as limiting factor, guiding further research to found new technical approaches in order to control the biomass-LCFA adsorption dynamics.

The use of inorganic adsorbents to capture LCFA prior to the anaerobic digestion process or the application of sequential low-energy ultrasonic pulses in order to control the adsorption-desorption kinetics were tested with interesting results. However, the effectiveness of these strategies was limited by the proportion of inorganic adsorbent/LCFA and the cumulative damaging effect of ultrasonic treatment over biomass, respectively. Further studies are thus required to optimize the efficiency and the applicability of these strategies.

Efficient conversion of complex high-strength lipid waste to methane was proved to be possible in a novel reactor system configuration combining saponification pre-treatment and digested solids recirculation to the anaerobic digestion process, to increase solids retention time. A start-up step consisting on pulse-feeding cycles of the fatty waste prior to the semi-continuous process promoted an adapted microbial community for LCFA mineralization. The feasibility of this system configuration for solid slaughterhouse fatty waste was evidenced at lab scale reactors, reaching organic matter removal efficiencies higher than 90%. The comparison of this configuration with systems without saponification or without digested solids recirculation confirmed the synergistic effect of both strategies. The use of high throughput sequencing approach (454-pyrosequencing) to characterize the evolution of the biodiversity and the phylogenetic structure of the microbial community during the operation of the tested configurations concluded that a selection of a defined functional acidogenic population (β-oxidizers) was induced by substrate pretreatment. Contrary, the solids recirculation resulted in an enrichment of the methanogenic biodiversity, mainly of hydrogenotrophic archaea.

Based on the satisfactory results obtained with the strategies studied in the present dissertation, it is expected that lipid-rich waste valorization will be a real alternative to increase renewable energy production through anaerobic digestion process.

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