Efficient lipid production from organic wastes by *Y. lipolytica*: volatile fatty acid as novel low-cost substrates

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Microbial oil biosynthesis is envisaged as a promising technology for sustainable production of chemicals and fuels, being *Yarrowia lipolytica* one of the most extensively studied yeasts for this purpose. So far, most of studies on lipid production with oleaginous yeasts have been carried out using sugars as carbon source [1]. However, due to their high production cost, considerable efforts have been directed towards finding alternative low cost sources such as organic wastes. In this context, volatile fatty acids (VFAs), that are generated from a wide variety of organic residues via anaerobic digestion (AD), can be metabolized and converted into lipids by yeasts [2]. Thus, the integration of these two bioprocesses (anaerobic fermentation and oleaginous fermentation) may allow the valorisation of residues, while increasing the revenues coming from the production of high value chemicals derived from oils.

This work assessed the potential of using the VFAs-rich digestate produced from microalgae biomass as carbon source for microbial oil production. In order to enhance VFA production yield during AD process, the control of operational conditions such as the Organic Loading Rate (OLR) is an interesting alternative [3]. In this case, the digestate was collected from an anaerobic digester fed with microalgae biomass at three different OLR (6, 9 and 12 g COD L^{-1} d^{-1}). *Y. lipolytica* CECT 1240 growth, substrate consumption and lipid production were evaluated on digestates.

VFAs production increased concomitantly with increasing OLR values reaching 9.5, 17.5 and 24.3 g VFAs L^{-1} for OLR 6, 9 and 12 g COD L^{-1} d^{-1}, respectively. Notwithstanding, the VFAs profile remained constant regardless the OLR, being acetic, propionic and butyric acid the most abundant (accounting for the 70% of the total VFAs content).

In terms of yeast growth, an increase in VFA concentration resulted in increasing biomass production (3.38 and 6.41 g biomass L^{-1} from 9.5 and 17.5 g VFAs L^{-1}, respectively), exception made for the most concentrated substrate (24.3 g VFAs L^{-1}) which limited yeast growth (3.88 g biomass L^{-1}). Remarkably, the highest lipid content (up to 56% w/w of dry biomass) was achieved when using digestate obtained at OLR 9. The fatty acid profile showed predominance of palmitic acid (C16:0) (7-14%), oleic acid (C18:1) (36-52%) and linoleic acid (C18:2) (7-21%). It is worth to highlight the unusual presence of odd carbon chains (C17:0) accounting up to 8% of total fatty acid. These unusual fatty acids have attracted significant attention since they are closer to commercialization which make them highly valuable products. Results presented herein proved the suitability of *Y. lipolytica* for producing lipids from low-cost substrates such as VFAs.

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