Mixotrophic and heterotrophic growth of microalgae using acetate from different production processes

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The high metabolic flexibility and biodiversity of microalgae make them promising systems to produce chemicals and high-value metabolites to be exploited in various industrial applications (Metting, 1996; Shimizu, 1996).
Currently, microalgae are mainly cultivated in phototrophic processes or in fermenters using glucose as substrate. Such configurations are too costly for the majority of potential applications and need improvements (Barbosa et al, 2023). The utilization of acetate as substrate to increase biomass productivity and reduce cost and environmental impacts is a promising solution. Indeed, in a future bio-based economy, acetate can be an excellent intermediate to link many industrial facilities since it can be synthesized by exploiting many different technologies starting from renewable resources as CO_2 and wastes (Bae et al, 2022; Turon at al, 2016).
In this study we present a detailed description of the different acetate synthesis processes alternative to the conventional methanol carbonylation, including pros and cons of each one: aerobic and anaerobic fermentations; thermochemical treatments; anaerobic digestion; C1 gas fermentation; microbial electrosynthesis (MES) and artificial photosynthesis. Then, the utilization of acetate as substrate for microalgae growth in mixotrophic and heterotrophic conditions is reviewed by describing the main metabolic and engineering aspects (strains, yields, growth rate, inhibition, productivity, process configuration) to be taken in consideration as guidelines for a rationale design of an algal cultivation process based on acetate as carbon source.
Finally, the study critically describes the state of the art of the coupling of acetate-rich streams with algal biomass production, highlighting the pros and cons and the main knowledge gaps to be filled with future research. Moreover, specific data of our study in coupling gas fermentation acetate production with heterotrophic cultivation of microalgae will be briefly presented, in order to confirm the potentiality in using acetate as carbon and energy source for microalgal cultivation. Through this approach, it was possible to generate protein from CO_2 through an innovative two-step process.

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