Growth kinetics and biomass production of *Chlorella sorokiniana* grown only on industrial wastewaters for a sustainable process development

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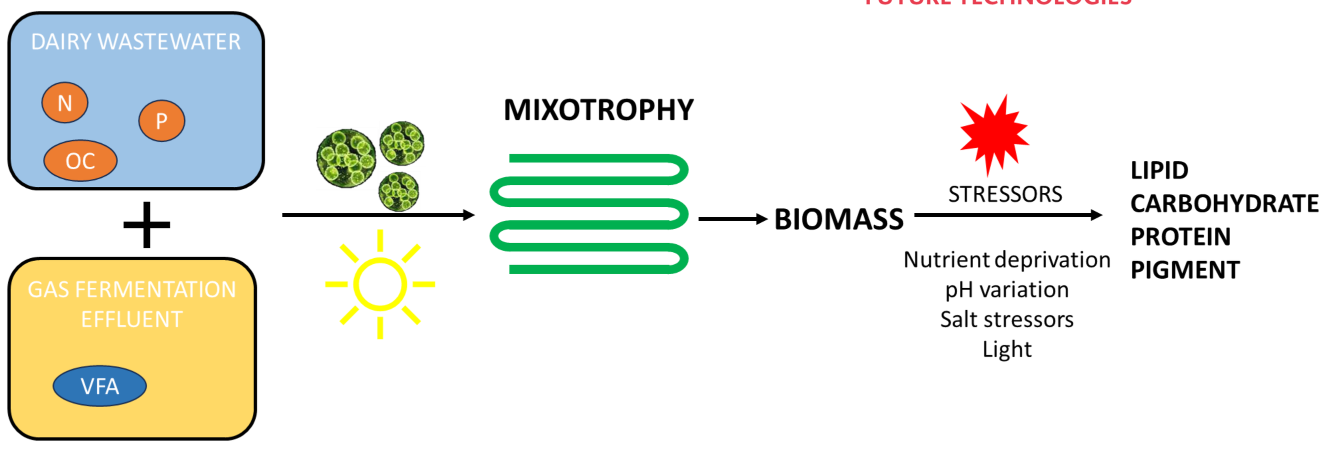
INTRODUCTION

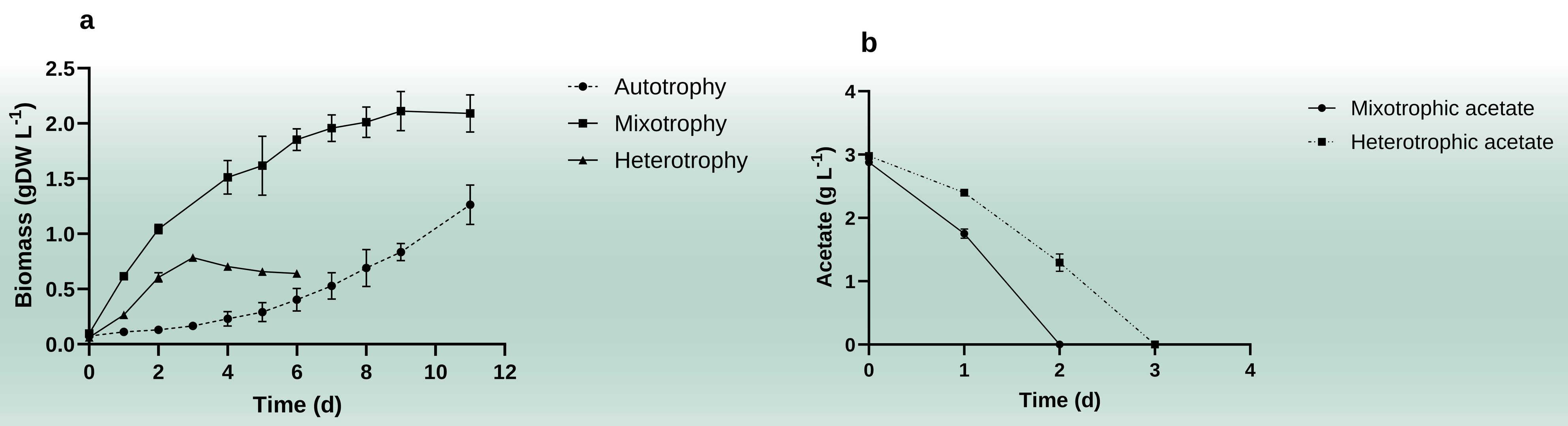
Microalgae biomasses have enormous potential as a resource of many compounds used in several industrial sectors (carbohydrates, proteins, lipids, pigments and secondary metabolites). Nevertheless, due to high energy consumption and the need for chemicals and water for the proper growth of microalgae, the industrial production of this biomass is not environmentally or economically feasible.
Here, to reduce water and chemicals consumption for biomass production, industrial wastewaters have been chosen as substrate: exhausted sludge from dairy wastewaters (DWW) and gas fermentation effluent (GFE). As a result, both cost reduction and bioremediation are performed.



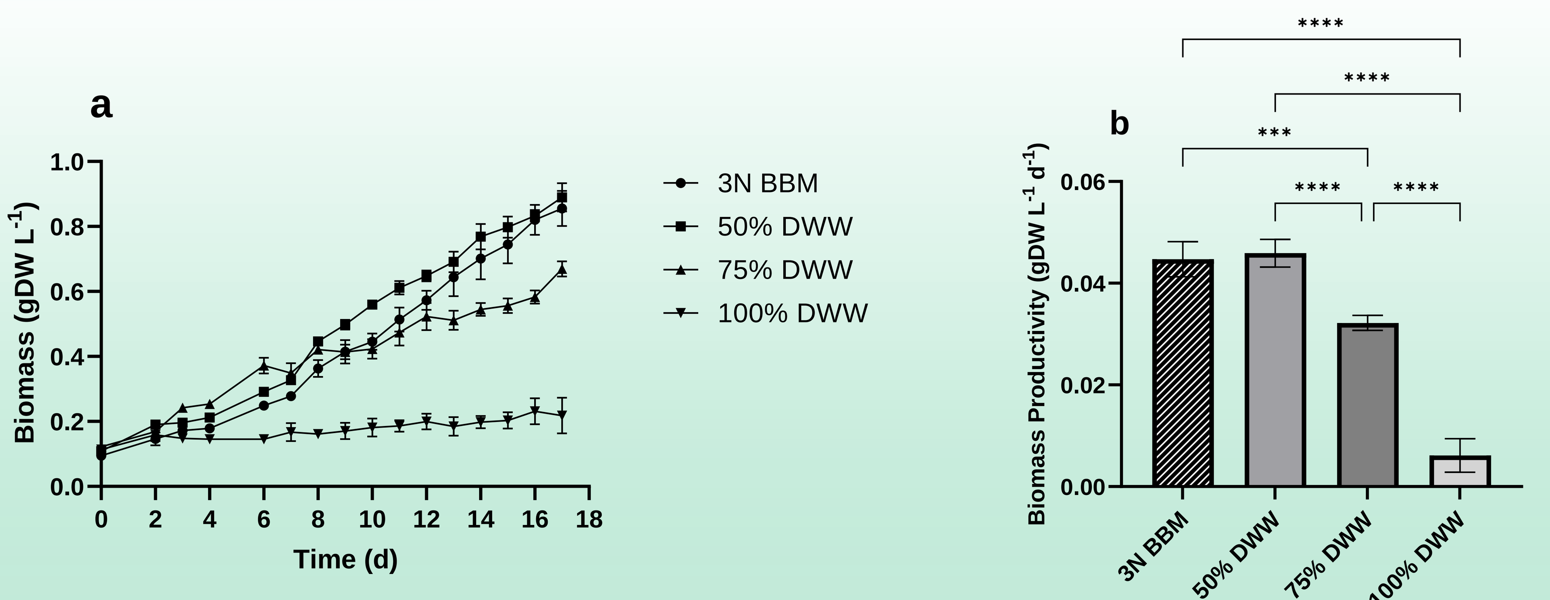
RESULTS

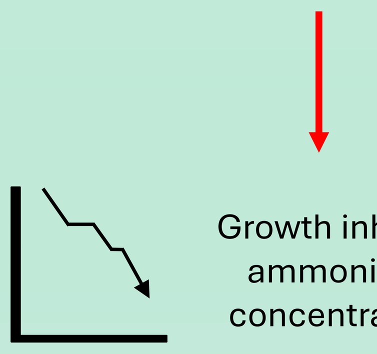
STANDARD CONDITION

Growth of *Chlorella sorokiniana* on standard medium in three different metabolisms: phototrophy, heterotrophy and mixotrophy. A detection of the best metabolism for accumulation of biomass utilizing acetate as organic carbon source for heterotrophy and mixotrophy.



GROWTH ON DWW

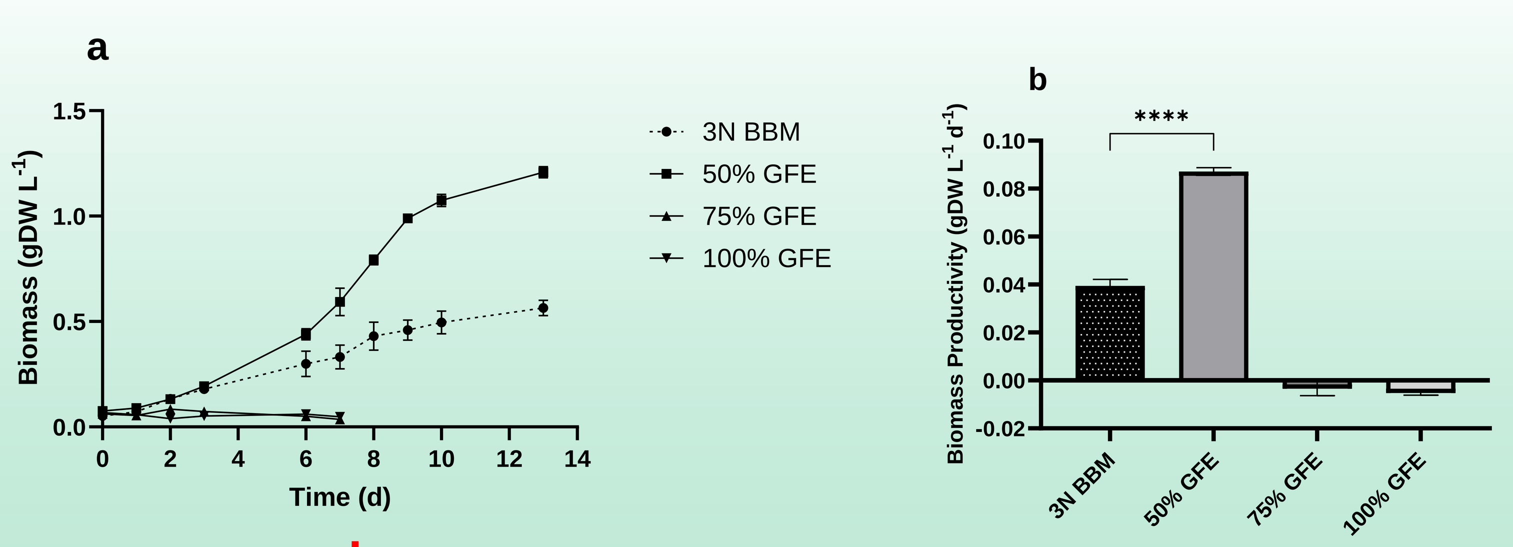


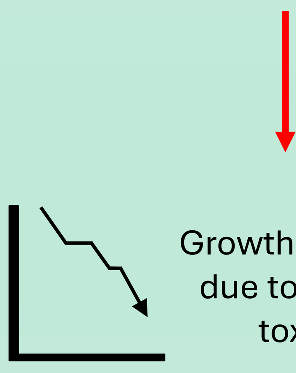


Growth inhibition due to ammonium nitrogen concentration in DWW

- 50% DWW led to biomass accumulation and growth rate comparable to the control condition
- Growth at 70% and 80% DWW slowed down the growth leading to a reduction in biomass production

GROWTH ON GFE

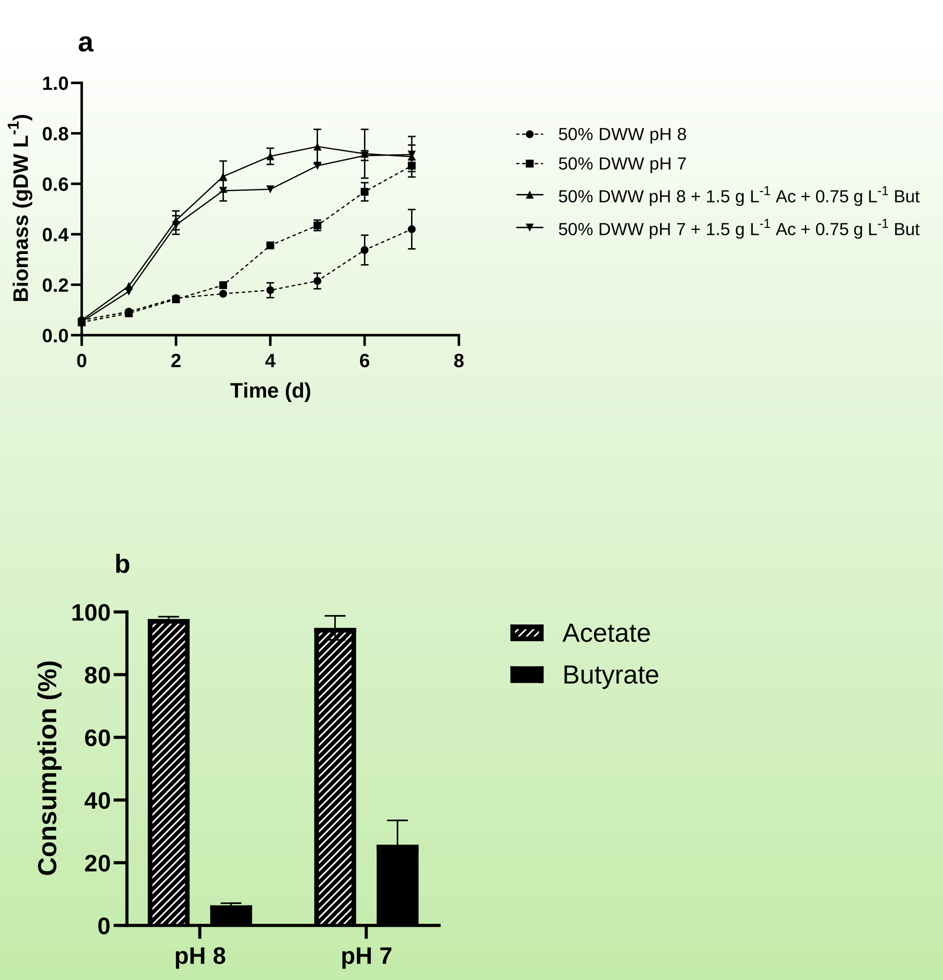




Growth inhibition due to hexanol toxicity

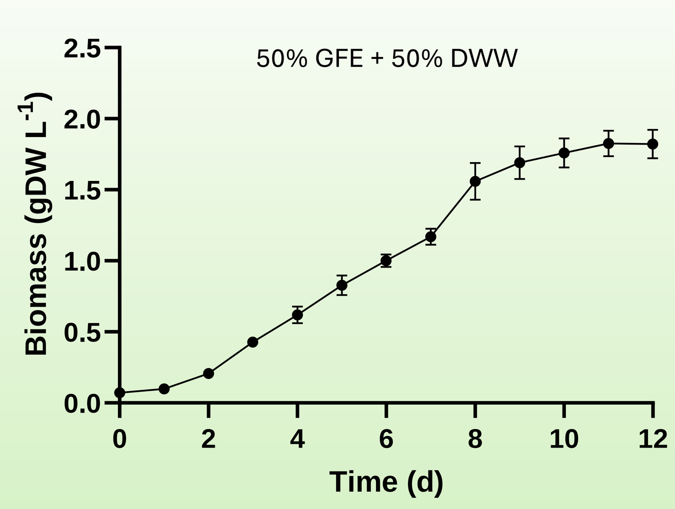
- When cultivated on GFE:water, at 50:50, the biomass productivity was 2.2-fold higher than that of 3N BBM
- 75% and 100% GFE completely inhibited the growth of *C. sorokiniana*

GROWTH ON BOTH DWW AND GFE



The different volatile fatty acids (VFAs) uptake (acetate and butyrate) was tested using 50% of DWW in 3N BBM.

- The uptake of butyrate is higher when pH is lower, reaching 26% after 7 days.
- when only butyrate was added at pH 7, a drastically higher uptake of 68% was recorded.
- when VFAs were added there were no differences on biomass accumulation at different pH.



Cultivation medium	Growth rate (d^{-1})	Maximum biomass production ($gDW\ L^{-1}$)
3N BBM	0.103 ± 0.002	0.814 ± 0.05
50% DWW	0.079 ± 0.003	0.827 ± 0.02
50% GFE	0.276 ± 0.001	1.209 ± 0.02
50% DWW + 50% GFE	0.289 ± 0.005	1.826 ± 0.007

- The highest growth rate and biomass accumulation, in flasks tests, were achieved.
- the exponential phase has lasted longer than the utilization of only GFE

CONCLUSIONS

This work focuses on the reduction of water and chemical consumption through the utilization of industrial wastewater as cultivation medium to reduce costs and bioremediate wastewater. Exhausted sludge from dairy wastewater (DWW) and gas fermentation effluent (GFE) have been considered. Ammonium nitrogen resulted to be toxic at concentration higher than 200 mg L^{-1}, resulting in the necessity to dilute DWW to be used for microalgal growth. Moreover, GFE contains high concentration of hexanol which resulted to be toxic, requiring to be diluted too. Test on DWW and GFE confirmed these toxicities. Thus, by mixing DWW and GFE in a 50:50 ratio, not only the toxic effect of both of them was prevented, but the highest biomass productivity was achieved (0.166 gDW L^{-1} d^{-1}). To sum up, our streamlined scheme, worthy to be scale up, tries to fit in a as much sustainable as possible concept, which preserves and recycles natural resources.