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Biological treatment of second cheese whey using marine microalgae/cyanobacteria based systems

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INTRODUCTION & AIM

Marine microalgae are of great scientific interest because of their high-value bioproducts. Recently, these valuable metabolic compounds have been intensively researched for their use in biotechnological applications in various fields such as pharmaceuticals and renewable energy sources. A major advantage of marine microalgae is the ability to use seawater for cultivation, which reduces operating costs. Second Cheese Whey (SCW) is a by-product of the whey cheese process and is characterized by high organic (d-COD) and nitrogen content, high salinity, high solids and an acidic pH. Dilution of this wastewater with seawater provides an ideal substrate for microalgae growth, as it is rich in organic and inorganic nutrients and has the same salinity as the marine culture. In this research study two different marine strains, the microalgae *Picochlorum costavermella* and the cyanobacterium *Geitlerinema* sp., were used for the biological treatment of SCW, with initial d-COD concentration of about 2000 mg/L.

METHOD

Experimental set-up

- Lab-scale Duran flasks (working volume 1L)
- Non-sterilized conditions
- Room temperature (24 ± 1 ◦C)
- Continuous stirring (150 rpm)
- Continuous illumination (2000 lux)
- Without mechanical aeration

Picochlorum costavermella

Measurements

- Optical microscopy studies
- Removals of inorganic and organic pollutants according to Standard Methods (APHA)
- Determination of intracellular bioproducts (proteins, carbohydrates, lipids)

***Geitlerinema* sp.**

RESULTS & DISCUSSION

The final biomass concentration for both cultures was similar, 710 mg/L for *Geitlerinema* sp. and 800 mg/L for *P. costavermella* after 10 days of cultivation (Fig. 1a). However, *P. costavermella* achieved higher nitrate removal (73%) than *Geitlerinema* sp. (53%) (Fig. 1b). High phosphorus removal rates were also achieved, around 75% in both cases (Fig. 1b).

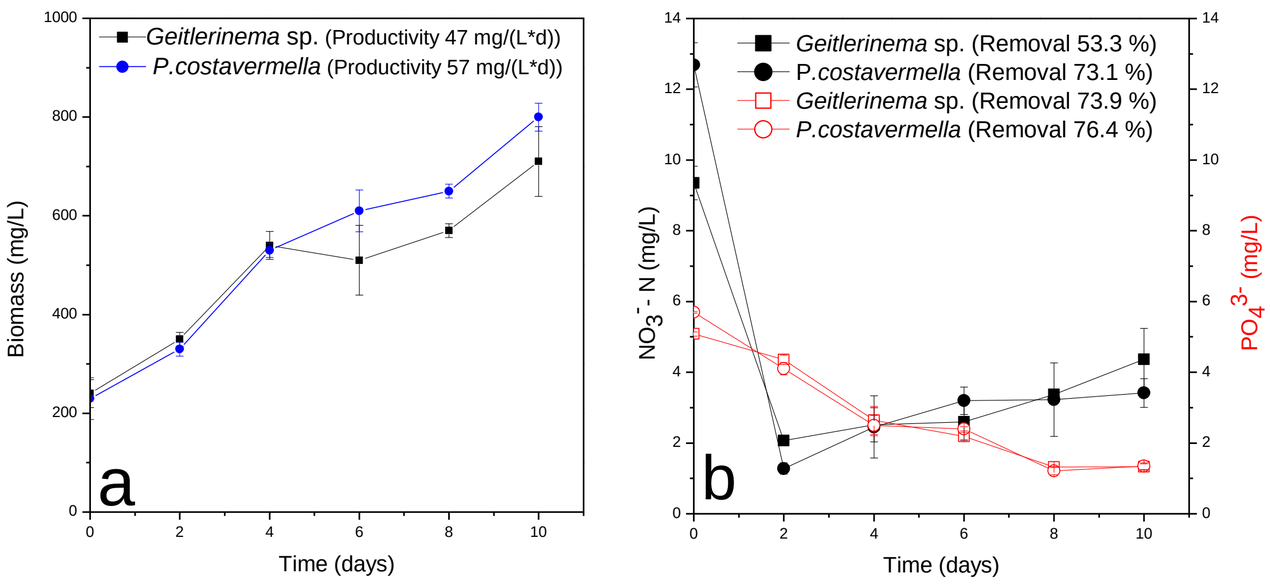

Figure 1. a)Total biomass production and b)removal of nutrients over time for *Geitlerinema* sp. and *Picochlorum costavermella.*

RESULTS & DISCUSSION

The organic load, in terms of d-COD and sugars, was successfully removed above 55%. These mixed cultures of marine cyanobacteria or microalgae with indigenous bacteria seem to degrade the d-COD organic matter until the 8th day, but after this day the degradation remains almost stable, reaching 55-65% removal (Fig. 2a). In contrast, the degradation of sugars is much higher and continuous until the last day of the experiments, with removal rates of 80-90% (Fig. 2b). This could be explained by the fact that sugars are simpler carbon compounds and may be more biodegradable by microorganisms.

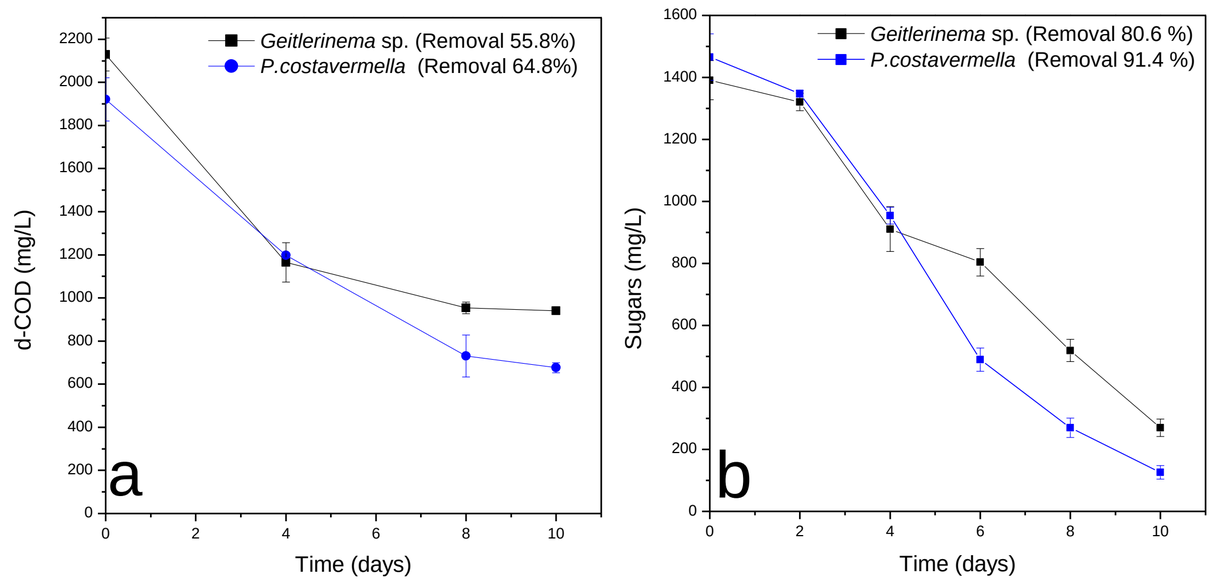

Figure 2. a)Removal of d-COD and b)Sugars for *Geitlerinema* sp. and *Picochlorum costavermella.*

The kinetics of bioproducts in dry biomass during cultivation show that the cyanobacteria-dominated culture tends to accumulate much more protein, up to 40%, and carbohydrate, up to 25%, instead of lipids (Fig. 3a). Instead, the microalgae-dominated culture achieved a much higher lipid content (11%) (Fig. 3b), up to twice that of the cyanobacteria.

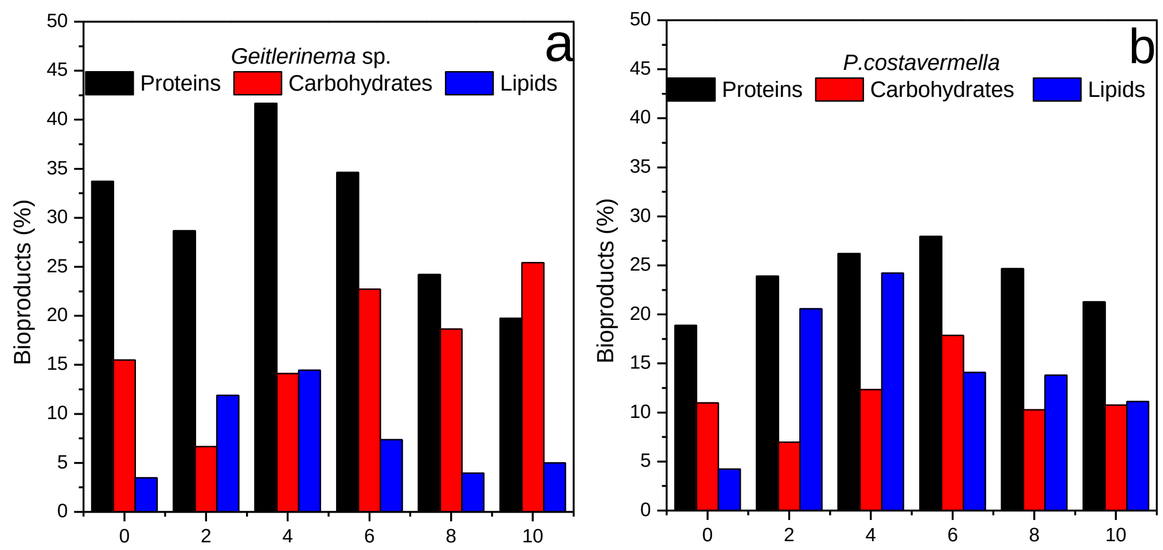

Figure 3. Accumulation of bioproducts (%) in dry biomass over time for a)*Geitlerinema* sp. and b)*Picochlorum costavermella.*

CONCLUSION

Marine microalgae/cyanobacteria-based systems can be used for dairy wastewater treatment and are mainly proposed as post-treatment steps. The simultaneously produced bioproducts could be useful in the biotechnology industry, in terms of protein, carbohydrate or lipid content.

FUTURE WORK / REFERENCES

The operation of these microalgae/cyanobacteria-based systems can be optimized using pilot-scale column bio-reactors (biofilters).

1) O. Tsolcha et al, Agroindustrial wastewater treatment with simultaneous biodiesel production in attached growth systems using a mixed microbial culture, Water 10 (2018) 1693, https://doi.org/10.3390/w10111693.

2) O.N. Tsolcha et al, A Leptolyngbya-based microbial consortium for agro-industrial wastewaters treatment and biodiesel production, Environ. Sci. Pollut. Res. 25 (2018) 17957–17966, https://doi.org/10.1007/ s11356-018-1989-z.