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A novel bioflocculation method to separate microalgal biomass cultivated on wastewater resources

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Thematic track: Innovation

Introduction

Due to the stricter regulations towards greenhouse gas emissions and to global and national pressure, new solutions are sought to produce energy. Third generation biofuels such as microalgae has the potential to produce energy without comprising food production. Creating phosphorus and nitrogen rich streams from wastewater can be combined together with algae cultivation enabling nutrient recovery (Valverde-Pérez et al., 2015). One of the main bottlenecks in algal wastewater technologies is harvesting the biomass, as traditional methods e.g. centrifuging and filtration through micro-filters are energy-expensive (Montingelli et al., 2015).

The objectives of the study are: (i) to develop a cost-efficient way of harvesting microalgae via flocculation using wasted activated sludge from a low solid retention time enhanced biological phosphorus removal (low SRT EBPR) system; (ii) to assess the optimal concentration of polyelectrolyte dosing; and (iii) to assess the effect of different algae/activated sludge ratios and the effect of activated sludge settleability on algal recovery.

Material and Methods

The mixed green microalgae, consisting of mainly *Chlorella sp.* and *Scenedesmus sp.* used for flocculation were grown on effluent wastewater from a laboratory scale EBPR system operated at 3-3.5 days SRT as a sequencing batch reactor (SBR), fed with preclarified wastewater from Lundtofte WWTP, Denmark. Wasted activated sludge was used for the flocculation experiments and cationic polyelectrolyte Poly(diallyldimethylammonium chloride) (PDADMAC) (Sigma Aldrich) was added as coagulant.

Two flocculation methods were tested: only activated sludge was used to flocculate algae and a two-step flocculation where the algae were flocculated first with PDADMAC and then activated sludge was added in a second step to enhance the coagulation. Standard methods were used for measuring TSS, VSS and sludge volume index (SVI, ml/g) and were applied on samples of algae and activated sludge. Optical density (OD) was measured at 750nm using the Synergy Microplate Reader® (BioTek) in a 24 well microplate. Recovery was calculated from the final OD values after 30 minutes settling period.

Results and Conclusions

As a result of the two-step flocculation an optimal concentration of 16 mg PDADMAC/ g algae resulted in 97% recovery of microalgae with a ratio of 0.1 g algae/g activated sludge (Fig. 1A). Compared to results where the algae was flocculated with PDADMAC alone (data not shown) an optimal concentration of 27.3 mg PDADMAC/g algae resulted in 92% recovery of microalgae. This shows both an improvement in recovery and a 41% decrease of the amount of PDADMAC needed when adding activated sludge in the second step. The settleability of the activated sludge expressed – measured using SVI – did not show to have a significant impact on the recovery of microalgae (Fig. 1B), where values of SVI varied within a wide range (100-1000 ml/g). Flocculating algae and activated sludge without polymer results in a substantial decrease of recovery (down to 40%, Fig. 1C). Increasing the mixing time of the flocculation between algae and activated sludge without polymer, shown not to have an effect on the recovery (Fig. 1C). We conclude that the cost-effective microalgal flocculation presented in this study is a promising solid-liquid separation approach resulting in high recovery of algal biomass.

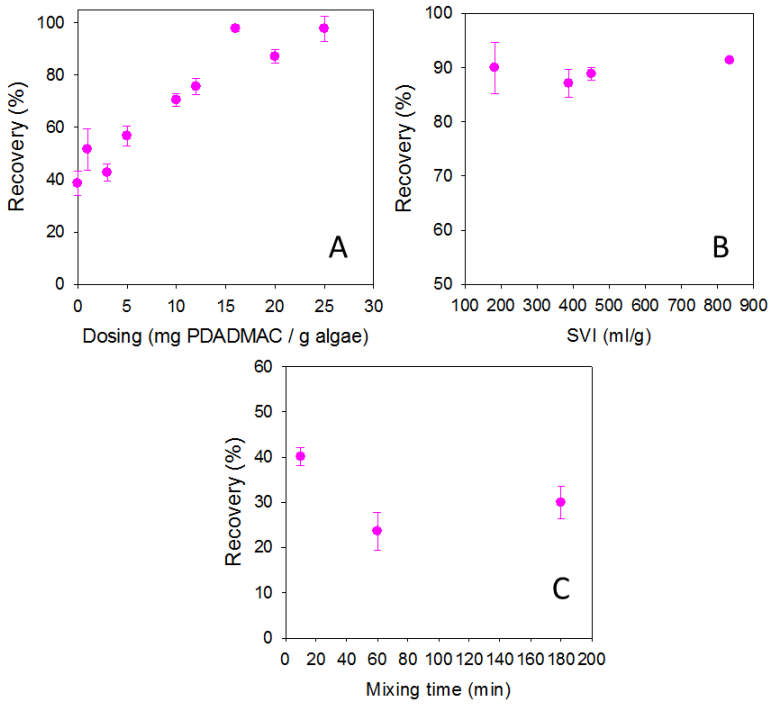

Figure 1 - The recovery of microalgae plotted as a function of concentration of PDADMAC (A), SVI (B). A) All points have same ratios (0.1 g algae/g AS) and SVI but with ranging SRT 3-3.5. B) All points have same concentrations of PDADMAC (20 mg/g algae) and SRT (3.5 days). Mixing time of algae and AS only (C) all points have same ratio (0.2 g algae/g AS), SVI but with ranging SRT (3-3.5). The recovery was calculated based on the OD750 measurements taken in the clear supernatant after 30 min settling time and initial OD in algae samples.

References

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