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Comparison of nutrient removal capacity and biomass settleability of four high-potential microalgal species

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HIGHLIGHTS

- ▶ Comparison of four algae for nutrient removal, biomass settleability and generation.
- ▶ Algal uptake was the main N and P removal mechanism for all the four algae.
- ▶ Three green algae species were suitable for water treatment and biomass production.
- ▶ Algal settleability should be concerned in the species selection of coupling system.

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ABSTRACT

Four common used microalgae species were compared in terms of settleability, nutrient removal capacity and biomass productivity. After 1 month training, except cyanobacteria *Phormidium* sp., three green microalgae species, *Chlamydomonas reinhardtii*, *Chlorella vulgaris* and *Scenedesmus rubescens*, showed good settleability. The N and P removal efficiency was all above 99% within 7, 4, 6 and 6 days for N and 4, 2, 3 and 4 days for P, resulting in the N removal rates of 3.66 ± 0.17, 6.39 ± 0.20, 4.39 ± 0.06 and 4.31 ± 0.18 mg N/l/d and P removal rates of 0.56 ± 0.07, 0.89 ± 0.05, 0.76 ± 0.09 and 0.60 ± 0.05 mg P/l/d for *Phormidium* sp., *C. reinhardtii*, *C. vulgaris* and *S. rubescens*, respectively. *Phormidium* sp. had the lowest algal biomass productivity (2.71 ± 0.7 $g/m^2/d$) and the other three green microalgae showed higher algal biomass productivity (around 6 $g/m^2/d$). Assimilation into biomass was the main removal mechanism for N and P.

1. Introduction

Algal-based biotechnology has been investigated for municipal wastewater treatment over the past few years (Oswald, 1988; Su et al., 2011b; Nurdogan and Oswald, 1995). Some researchers also tested the feasibility of algal–bacterial symbiotic system for the agricultural and industrial wastewater treatment (Munoz, 2005; Munoz and Guieysse, 2006). As algae could increase the dissolved oxygen concentration in the culture, assimilate nutrient and CO_2 through photosynthetic metabolism thus integration reducing energy requirement for mechanical aeration, wastewater purification and green gas mitigation. The by-product of this treatment process is a high yield of protein-rich algal biomass which could be further used for agricultural fertilizer, biofuels and biogass production (Logan and Ronald, 2011; Rawat et al., 2011). All of these make algal-based biotechnology attractive compared with the conventional treatment technologies.

However, two bottlenecks are still the major limitations of the exploitation of this technology. The first one is the selection of highly-effective microalgae species. Some algae species are carefully chosen in terms of nutrient removal rate and biofuel generation potential. Among them, cyanobacteria *Phormidium* sp. with a high tolerance to extreme temperatures was an efficient strain for tertiary wastewater treatment (Olguin, 2003). The previous study also showed that *Chlamydomonas* and *Chlorella* were two dominant algae strains and played important roles during long-term piggery wastewater treatment (de Godos et al., 2009; Kong et al., 2010). And *Scenedesmus* was a high-potential algae species for industrial wastewater treatment and high in lipid concentration which could be further used for biodiesel production (Termini et al., 2011; Martinez et al., 2000; Zhang et al., 2008). But most of these algae were tested separately with different bioreactor configurations and environmental conditions, and few reports focused on

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