



Research article

Enhancing microalgae biomass production: Exploring improved scraping frequency in a hybrid cultivation system

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ABSTRACT

Recently, hybrid systems, such as those incorporating high-rate algal ponds (HRAPs) and biofilm reactors (BRs), have shown promise in treating domestic wastewater while cultivating microalgae. In this context, the objective of the present study was to determine an improved scraping frequency to maximize microalgae biomass productivity in a mix of industrial (fruit-based juice production) and domestic wastewater. The mix was set to balance the carbon/nitrogen ratio. The scraping strategy involved maintaining 1 cm wide stripes to retain an inoculum in the reactor. Three scraping frequencies (2, 4, and 6 days) were evaluated. The findings indicate that a scraping frequency of each 2 days provided the highest biomass productivity (18.75 g total volatile solids m⁻² d⁻¹). The species' behavior varied with frequency: *Chlorella vulgaris* was abundant at 6-day intervals, whereas *Tetrademus obliquus* favored shorter intervals. Biomass from more frequent scraping demonstrated a higher lipid content (15.45%). Extrapolymeric substance production was also highest at the 2-day frequency. Concerning wastewater treatment, the system removed 93% of dissolved organic carbon and ~100% of ammoniacal nitrogen. Combining industrial and domestic wastewater sources to balance the carbon/nitrogen ratio enhanced treatment efficiency and biomass yield. This study highlights the potential of adjusting scraping frequencies in hybrid systems for improved wastewater treatment and microalgae production.

1. Introduction

Microalgae are recognized as a promising solution for wastewater treatment due to their high biomass productivity and ability to use sunlight as their main energy source (Choudhary et al., 2020). Using microalgae in wastewater treatment removes excess nutrients, reduces the risk of water body eutrophication, and contributes to carbon dioxide (CO₂) sequestration from the atmosphere. Several studies have demonstrated the effectiveness of microalgae-based wastewater treatment processes (Assis et al., 2017; Couto et al., 2018; Magalhães et al., 2022).

To further enhance these processes, it is crucial to consider the wastewater mix to balance the carbon/nitrogen (C/N) ratio. Previous studies evaluated the optimal C/N ratio. For instance, Chiu et al. (2015) found that a C/N ratio 6 ensures sufficient nutrient availability,

enhancing microalgae growth. Zheng et al. (2018) found a C/N ratio 7.9 optimal for nutrient removal and biomass production. Other works reported the best biomass production at a C/N ratio 5 (Xu et al., 2017; Yan et al., 2013). In this context, a balanced C/N ratio is essential for improved microalgal growth, as it affects the metabolic pathways involved in biomass accumulation and nutrient removal (Gama et al., 2023).

Improving microalgae harvesting through biofilm formation in support material using wastewater as the culture medium was also evaluated (Assis et al., 2020; Boelee et al., 2014; Liu et al., 2013; Wang et al., 2018). Hybrid systems, such as coupling suspended and attached culture systems, have resulted in higher algal yields than conventional high-rate algal ponds (HRAPs), with simpler and cheaper biomass collection (Assis et al., 2020). Among these hybrid systems, biofilm reactors (BRs)

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