Gonçalves et al. Bioresources and Bioprocessing (2015) 2:21
DOI 10.1186/s40643-015-0051-y

Bioresources and Bioprocessing
a SpringerOpen Journal

RESEARCH Open Access

Surface physicochemical properties of selected single and mixed cultures of microalgae and cyanobacteria and their relationship with sedimentation kinetics

Ana L Gonçalves, Carla Ferreira, Joana A Loureiro, José CM Pires and Manuel Simões*

Abstract

Background: Microalgae are photosynthetic microorganisms presenting a diversity of biotechnological applications. However, microalgal cultivation systems are not energetically and economically feasible. Possible strategies that can be applied to improve the feasibility of microalgal production include biofouling control in photobioreactors, the use of attached growth systems and bioflocculation. These processes are ruled by surface physicochemical properties. Accordingly, the surface physicochemical properties of *Chlorella vulgaris*, *Pseudokirchneriella subcapitata*, *Synechocystis salina* and *Microcystis aeruginosa* were determined through contact angle and zeta potential measurements. Additionally, mixed cultures of the selected microorganisms were performed. Sedimentation kinetics of the studied cultures was also evaluated to understand how surface physicochemical properties influence microalgal recovery.

Results: All studied microorganisms, except *S. salina*, presented a hydrophilic surface. The co-culture of *S. salina* with the other studied microorganisms resulted in a more hydrophobic algal suspension. Regarding zeta potential determinations, all studied suspensions presented a negatively charged surface (approximately -40.8 ± 4.4 mV). Sedimentation experiments have shown that all microalgal suspensions presented low microalgal recovery efficiencies. However, a negative linear relationship between microalgal removal percentage and free energy of hydrophobic interaction was obtained.

Conclusions: The evidence of a relationship between microalgal removal percentage and free energy of hydrophobic interaction demonstrates the importance of surface physicochemical properties on microalgal settling. However, the low recovery efficiencies achieved, as well as the high net zeta potential values determined, indicate that another factor to consider in microalgal settling is the ionic strength of the culture medium, which play an important role in suspensions' stability.

Keywords: Cyanobacteria; Microalgae; Mixed cultures; Sedimentation kinetics; Surface physicochemical properties

Background

Microalgal culturing has been the focus of several research studies worldwide, due to the wide variety of biotechnological applications described for these photosynthetic microorganisms [1,2]. When growing autotrophically, microalgae convert CO_2 (from atmosphere or flue gas emissions) into organic carbon compounds, thus reducing the CO_2 accumulation in the atmosphere [3-6]. Additionally, microalgae assimilate other compounds, such as nitrogen and phosphorus, frequently found in wastewaters, meaning that these microorganisms may play an important role in wastewater treatment processes [7-10]. Finally, microalgal biomass has several applications [1,11-13]: (i) human food and animal feed; (ii) production of cosmetics, drugs and functional food; and (iii) biofuels. However, microalgal cultivation still presents high process costs, which are mainly due to the low biomass productivities and the associated harvesting costs, accounting for 20% to 30% of biomass production costs [14]. Moreover, it requires large amounts of water and nutrients, which is the reason to be considered a process with high environmental impact [15].

To improve biomass productivities in microalgal photobioreactors (PBRs), new strategies should be adopted to

* Correspondence: mvs@fe.up.pt
LEPABE, Departamento de Engenharia Química, Faculdade de Engenharia, Universidade do Porto, Rua Dr. Roberto Frias, 4200-465 Porto, Portugal