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Centrate grown *Chlorella fusca* (Chlorophyta): Potential for biomass production and centrate bioremediation

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ABSTRACT

This paper describes the ability of microalgae *Chlorella fusca* (*Chlorophyta*) to bioremediate centrate obtained by the centrifugation of sludge from an urban wastewater treatment plant. Microalgae were grown under solar radiation in UV transparent cylindrical vessels in a batch culture for 35 days at different centrate concentrations (33%–66%–100%) and compared to microalgae grown in a Basal bold medium (BBM) with ammonium (BBM-NH_4) or nitrate (BBM-NO_3) as the inorganic nitrogen source. Biomass productivity was evaluated as cell weight and cell numbers. Photosynthetic activity was measured by in vivo chlorophyll *a* fluorescence associated with photosystem II. The ionic composition of the media, total internal carbon, nitrogen, protein and lipid content were evaluated. Culture growth in centrate treatments presented a lag phase, but reached, under 100% centrate, a higher number of cells ($296{\cdot}10^6$ cellsmL^{-1}) and equal biomass production (3.5 gL^{-1}) than control treatment cultures in the stationary phase. The photosynthetic status, expressed as maximal quantum yield (Fv/Fm), was maintained high throughout time in BBM-NO_3 treatment whereas under 100% centrate it reached similar values in the stationary phase. Maximal electron transport rate (ETR_{max}), estimator of photosynthetic capacity, was higher in BBM-NO_3 (with a maximum value of 10.2 mmol $e^{-}m^{-3}s^{-1}$), however 100%-C treatment reached similar values (8.6 mmol $e^{-}m^{-3}s^{-1}$). Lipid and Protein productivities were higher under BBM-NO_3 (58.8 $mg^{-1}L^{-1}d^{-1}$, 124.07 $mg^{-1}L^{-1}d^{-1}$) and 100% centrate (42.5 $mg^{-1}L^{-1}d^{-1}$, 119.92 $mg^{-1}L^{-1}d^{-1}$). Nitrogen deficiency in 66 and 100% centrate grown algae was related to an increase of the lipid to protein ratio. Centrate as the culture media was demonstrated to be a good candidate for biomass growth i.e. after a period of adaptation, photosynthetic state and productivity were similar to those in a traditional culture media. The reduction of N and P in centrate shows a promising application for the depuration of centrate with a reduction of costs.

1. Introduction

Algae biomass production is costly due to different factors. To begin with, a good deal of energy is needed for vigorous hydrodynamics (pumps blowers or pumps driving) as well as for harvest (centrifugal) and drying systems (lyophilized or spry-dry). In addition, to mass produce biomass, either in closed or open systems, a large amount of fertilizers, microelements, and vitamins [1,2,3,4,5] is needed. Centrate contains nutrients that could be exploited for algae growth [6,7] reducing an important share of the production costs [8].

Microalgae are able to grow in many environments with very different characteristics and they are capable of surviving changes in environmental conditions. Its capacity to depurate has been studied over the last decade to find solutions to water contamination [9,10,11]. Microalgae can be used to depurate different types of effluents from: fish farms [12,13], pig farms [14,15,16], or urban wastewater treatment plants (WWTP) [17,18,19,20]. Recently, centrate has been used as culture media for microalgae biomass production due to their high content on nitrogen and phosphorus, following the anaerobic digestion of sludge produced in urban wastewater treatment plants. *Chlorella* sp. has shown a high capacity for nutrient removal and productivity potential in centrate [21,22,19,8]. However, it is still necessary to find new ways to improve the current state of art in the depuration of centrate and production of commercially valuable microalgae biomass. In order to improve current processes, a better understanding of the effects that centrate has on microalgae cultures is needed [23,24,25,26]. Centrate characteristics and composition differ depending on the urban wastewater treatment plant of origin, but also over time due to fluctuations in plants operations. This represents a challenge for the production of microalgae in this media and for the

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