Bioresource Technology 125 (2012) 75–81

Contents lists available at SciVerse ScienceDirect

Bioresource Technology

journal homepage: www.elsevier.com/locate/biortech

Spectral conversion of light for enhanced microalgae growth rates and photosynthetic pigment production

Seyedeh Fatemeh Mohsenpour [a], Bryce Richards [b], Nik Willoughby [a,*]

[a] Institute for Biological Chemistry, Biophysics and Bioengineering, School of Engineering and Physical Sciences, Heriot-Watt University, Edinburgh EH14 4AS, UK
[b] Institute of Photonics and Quantum Sciences, School of Engineering and Physical Sciences, Heriot-Watt University, Edinburgh EH14 4AS, UK

HIGHLIGHTS

- ▶ Growth/chlorophyll production of microalgae under varied light conditions studied.
- ▶ Natural light source modified using various luminescent acrylic sheets.
- ▶ Improved growth rates achieved under wavelength-modified light.
- ▶ Chlorophyll-a production increased under wavelength-modified light.
- ▶ Improved growth under modified natural light reduces need for artificial lighting.

ARTICLE INFO

Article history:
Received 15 June 2012
Received in revised form 16 August 2012
Accepted 19 August 2012
Available online 31 August 2012

Keywords:
Microalgae
Light wavelength
Luminescent
Photosynthetic pigments
Solar

ABSTRACT

The effect of light conditions on the growth of green algae *Chlorella vulgaris* and cyanobacteria *Gloeothece membranacea* was investigated by filtering different wavelengths of visible light and comparing against a model daylight source as a control. Luminescent acrylic sheets containing violet, green, orange or red dyes illuminated by a solar simulator produced the desired wavelengths of light for this study. From the experimental results the highest specific growth rate for *C. vulgaris* was achieved using the orange range whereas violet light promoted the growth of *G. membranacea*. Red light exhibited the least efficiency in conversion of light energy into biomass in both strains of microalgae. Photosynthetic pigment formation was examined and maximum chlorophyll-a production in *C. vulgaris* was obtained by red light illumination. Green light yielded the best chlorophyll-a production in *G. membranacea*. The proposed illumination strategy offers improved microalgae growth without resorting to artificial light sources, reducing energy use and costs of cultivation.

1. Introduction

Cultivation of photosynthetic microalgae has received increased attention as a potential source of high-value biochemical components such as natural colourants, polyunsaturated fatty acids, proteins and polysaccharides (Chen et al., 2010a,b) as well as being a potential biofuel source or food material. In addition microalgae cultivation has been considered as greenhouse gas mitigation strategy in which solar-driven cells capture carbon dioxide (CO_2) and convert it into organic chemicals (Chisti, 2007).

In photoautotrophic cultivation mode light is the main source of energy and inorganic carbon (such as CO_2) is used as the carbon source (Huang et al., 2010). Photons can be absorbed as nutrient by microalgae cells thus the quality of light in terms of intensity and wavelength is critical for cell growth (Wang et al., 2007).

Specific growth rate and photosynthetic pigment formation are highly influenced by the light source. Up to date the only light sources which have been used for illumination of microalgae cultures and capable of emitting light in specific wavelengths are light emitting diodes (LEDs) (Wang et al., 2007). Long life expectancy, low heat generation and efficient light conversion are the advantages of using a light source such as LED with selective wavelengths (Chen et al., 2010a,b). However, to date no research has been focused on using luminescent acrylic sheets as a tool for selecting certain wavelengths of sunlight for illumination of microalgae cultures. The proposed technique uses transparent thermoplastic polymethyl methacrylate (PMMA) doped with fluorophores against a solar simulator to filter out the undesired wavelengths. Fluorophores contain luminescent molecules and depending on their colours they absorb light at specific wavelengths and re-emit

* Corresponding author. Tel.: +44 (0) 131 451 4377; fax: +44 (0) 131 451 3129.
E-mail addresses: sm627@hw.ac.uk (S.F. Mohsenpour), B.S.Richards@hw.ac.uk (B. Richards), N.A.Willoughby@hw.ac.uk (N. Willoughby).

0960-8524/$ - see front matter © 2012 Elsevier Ltd. All rights reserved.
http://dx.doi.org/10.1016/j.biortech.2012.08.072