A modelling framework to represent the complementary chromatic adaptation of cyanobacteria grown in consortia with green microalgae

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Microalgae are microorganisms that can be employed to reach the objectives of the EU on carbon neutrality by 2050. They grow using CO_2 as carbon source and light as primary source of energy. However, using solar light makes the microalgae production vary depending on the daily weather. Therefore, in the last decade, concurrently with the Light Emitting Diodes (LEDs) improvement, it has been more common to exploit artificial light in order to obtain a stable and continuous production throughout the year at a relatively low cost.

LEDs, with respect to other form of illumination, have higher electrical efficiencies and their colour can be modified by using different semiconductors. This feature can be used to tune their emission spectra to match the pigments absorption.

However, scaling up microalgae production is often hindered by a low photosynthetic efficiency compared to the one obtained at laboratory scale (de Vree et al. 2015). This is caused by the little availability of models that can fairly represent the light absorption and growth of microalgae cultures. Indeed, most of the available models only consider as main operating variable the overall light intensity and not the light spectrum.

In order to improve the photosynthetic efficiency, namely the capacity of microalgae of converting light energy into chemical energy, Borella et al. (2023) studied the effect of different LED lamps on a consortium made of a microalga and cyanobacterium capable of performing complementary chromatic adaptation (CCA). CCA is a mechanism used to change the phycobiliproteins content in order to adapt the absorption spectrum of the culture to the incident one. This characteristic has been exploited in order to use most of the incoming photons and to improve the photosynthetic efficiency of the culture. It has been found out that the consortium is able not only to have a higher biomass production with respect to the axenic cultures but also a higher photosynthetic efficiency under low irradiances.

In this framework, this study proposes a model capable of representing the behaviour of the consortium and of the axenic cultures mainly focusing on the effect of the different light spectrum without omitting the effect of light acclimation under the CCA mechanism. In order to predict the light absorption by the culture, an extinction coefficient that depends on the wavelength is evaluated. This permits to characterize the incoming light and to describe how different wavelengths are absorbed depending on the species considered.

Borella, L., Marchese D., Trivellin N., Sforza E., (2023). Complementary chromatic adaptation as a strategy to increase energy conversion efficiency of microalgae-cyanobacteria consortia in continuous LED photobioreactors. *Energy. Convers. Manage.* **294**, 117549.

De Vree, J. H., Bosma R., Barbosa M. J., Wijffels R. H., (2015). Comparison of four outdoor pilot-scale photobioreactors. *Biotechnol biofuels.* **8,** 1-12.

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