Cyanoprokaryota cultivation with the lighting unit under different light regimes

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Key message. The continuous phototrophic growth and light / dark cycled regime showed comparable OTR, max. μ 0.06 h⁻¹, biomass concentration ca. 0.8 g · L⁻¹. During growth with 1.5 g · L⁻¹ glucose compared to the phototrophic showed the higher OTR.

Keywords: cyanobacteria, photobiotechnology, *Limnospira*

The cultivation of cyanoprokaryota in Device for Sterile Online Measurement system: light distribution over the shake flask bottom and *Limnospira* strain PCC 9108 (earlier *Arthrospira* (Nowicka-Krawczyk et al. 2019)) were maintained in Zarrouk medium. The light intensity of 180 $\mu\text{mol m}^{-2} \text{s}^{-1}$ measured via Li-Cor Quantum Sensor for photosynthetic active radiation 400-700 nm. Specific growth rate (μ) calculated during time interval of exponential growth from biomass concentration

($\mu_x = \frac{\ln \frac{c_x}{c_0}}{\Delta t}$) and from oxygen transfer rate values ($\mu_{\text{OTR}} = \frac{\text{OTR} \times Y_{\text{O}_2}}{c_x}$) in h⁻¹. c_x – biomass concentration, Δt – measuring time interval; yield

coefficient for biomass per oxygen $Y_{\text{O}_2} = 0.5076 \frac{\text{g}_x}{\text{g}_{\text{O}_2}}$ respectively to (Vonshak, 1997); OTR – oxygen transfer rate ($\text{g}_{\text{O}_2} \text{L}^{-1} \text{h}^{-1}$)

as and carbon transfer rate automatically calculated by online monitoring photosynthetic unit. Dry biomass concentration c_x ($\text{g}_x \cdot \text{L}^{-1}$) determined via OD at 750 nm of the cell suspension. Correlation of OD and dry biomass concentration advance performed as $c_x = \text{OD}_{750 \text{ nm}} \cdot 0.82 \text{ g} \cdot \text{L}^{-1}$ respectively to (Petrukhina, Lykov 2018).

The cultivation with the lighting unit under different light regimes obtained: Specific growth rate μ (h⁻¹): 0.06 / 0.054 to continuous phototrophic and 0.058 / 0.055 to 16 h / 8 h light / dark cycled phototrophic. Minim. OTR -1.5 mmol L⁻¹ h⁻¹. The total oxygen transfer ($\text{mmol} \cdot \text{L}^{-1}$): 80 to continuous phototrophic, 50 to 16 h / 8 h light / dark cycled phototrophic and 60 to continuous photomixotrophic. The biomass related oxygen production in mmol O₂ g_x⁻¹ h⁻¹: 0.18 to continuous phototrophic and 0.20 to 16 h / 8 h light / dark cycled phototrophic. The obtained specific growth rate μ for phototrophic cultivated was in the range of values reported in literature for cyanoprokaryota suitable light intensity: 0.051 h⁻¹ (Tomaselli et al. 1997); 0.048 h⁻¹ (Vonshak 1997); 0.058 h⁻¹ (Xue et al. 2011).

The investigated cells able grew fully photosynthetically under the implemented warm white LED. OTR showed an increase in the first 30 h up to a mean (0.5 mmol L⁻¹ h⁻¹) followed by a decrease until 48 h (minim. of -1.5 mmol L⁻¹ h⁻¹) and then increased again to a value of ca. -0.5 mmol L⁻¹ h⁻¹. The carbon dioxide transfer rate showed little deviation from 0 because produced carbon dioxide during respiratory activity was immediately dissolved in the liquid strong alkaline Zarrouk medium of pH and not emitted to the gas phase. The oxygen transfer showed an cells oxygen consumption of 18 mmol · L⁻¹ and photosynthetic production of overall 80 mmol · L⁻¹. The oxygen transfer decelerated from 48 to 80 h cultivation, then a linear decline was observed.

To detect cells photosynthetic behaviour under changing light regime was applied a light / dark cycle. OTR during the dark period a close to zero (oxygen transfer at constant level) and during the light period – as under continuous light. OTR dropped down after 64 h cultivation to a minimum of -1.5 mmol L⁻¹ h⁻¹ when biomass concentration reached approx. 0.2 g · L⁻¹.

Photomixotrophic regime has been applied and Zarrouk medium was supplemented with a suitable glucose concentration (1.5 g · L⁻¹) (Vonshak 1997; Chojnacka, Zielinska 2012). At the cultivations beginning the photomixotrophic culture showed a higher OTR than the phototrophic and then – a lower decrease until 48 h cultivation to minim. – 1.5 mmol L⁻¹ h⁻¹ than phototrophic with – 2.0 mmol L⁻¹ h⁻¹. Glucose residual concentration was approx. 1 g · L⁻¹. Consequently, it was not consumed completely.

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