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PHOTOHERETROPHIC CULTURE OF *Chlorella vulgaris* FOR BIOMASS PRODUCTION IN CSTR AND FLAT PANEL AIRLIFT PHOTOBIOREACTORS

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Introduction. Microalgae are rich source of protein, carbohydrates, and especially pigments as chlorophyll and carotenoids, for this reason the cultivation of these photosynthetic microorganisms is an attractive process (1). In commercial production of microalgae biomass, high cell density culture is desirable in order to reduce the cost for down-stream processing. The growth characteristics and composition of microalgae are known to significantly depend on the cultivation conditions: culture media, light intensity, gas exchange and photobioreactor type (2). Photoheterotrophic culture involves the addition of organic carbon source and light as energy source in order to increase biomass productivity and metabolites of interest (3).
The aim of this study was to evaluate the biomass and pigment production using a typical stirred tank and flat panel airlift photobioreactor under photoheterotrophic culture.

Methodology. The fresh water microalga *Chlorella vulgaris* was used. The effect of reactor type was evaluated under photoheterotrophic culture using glucose (2 g L^{-1}) as carbon source, light intensity of 100 µmol photon m^{-2} s^{-1} and light/dark cycle photoperiod (12:12 h) were used as energy source. A CSTR of 3 L of capacity (Applikon, Netherlands) and flat panel airlift (FPA) photobioreactor of 3 L of capacity were evaluated. Aeration rate of 0.6 vvm, 27±2 °C of temperature, working volume of 2 L and initial cell concentration of $1x10^6$ cel mL^{-1} were used for both reactors. Microalgae growth, pigments production and substrate consumption were daily evaluated. The final cell concentration was reported as dry weight (g L^{-1}). Pigments were extracted using dimethylsulphoxide (DMSO) and the OD was measured at 649, 665 and 480 nm to calculate pigment content (4). Substrate consumption was evaluated by colorimetric method (5).

Results. Figure 1 illustrates the growth profile and substrate consumption for *C. vulgaris* in the two systems evaluated. Maximal growth was observed at 168 and 144 h for CSTR ($62.79x10^6$ cel mL^{-1}) and FPA ($35.29x10^6$cel mL^{-1}) respectively. It can be seen that during the first 48 h around of 50% of glucose decrease to consume completely after 120 h in the CSTR reactor while for FPA was consumed at 144 h. Similar biomass production was obtained for both reactors (Table 1). This can be due to the different size and contents of cells. In pigment production, FPA shows more chlorophyll content than CSTR, while carotenoids production was similar in both reactors. These results suggest that FPA has a better photosynthetic efficiency than CSTR.

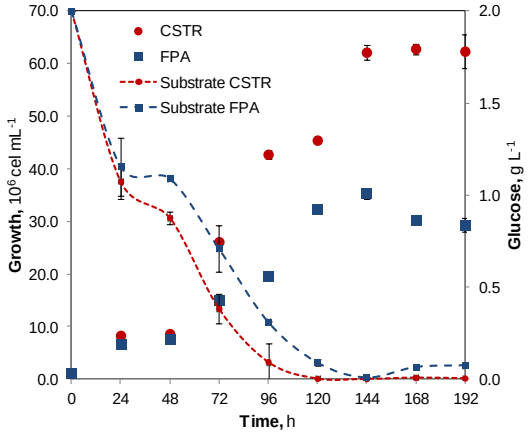

Fig. 1. Growth and substrate consumption of *C. vulgaris* under photoheterotrophic culture using CSTR and FPA photobioreactor.

Table 1. Final biomass and pigment content of *C. vulgaris* under photoheterotrophic culture using CSTR and FPA photobioreactor.

Reactor	Responses		
	Biomass (g L^{-1})	Total chlorophyll (mg L^{-1})	Carotenoids (mg L^{-1})
CSTR	1.45±0.00[a]	39.50±3.78[a,b]	5.62±1.11[a]
FPA	1.43±0.05[a]	43.64±2.31[a]	4.61±2.56[a]

Conclusions. According to the results similar growth performance and pigments yields were observed in CSTR and FPA. However, FPA has more advantages than CSTR reactor as lower energy consumption due to pneumatic agitation and greater light incidence.

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