Scale-up cultivation of recombinant *Synechococcus* under natural light conditions for production of ethylene

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Cyanobacteria are globally considered as photosynthetic platforms for production of hydrocarbons, albeit at laboratory scales. However, to elevate their application at the commercial scale, scale up studies under real time cultivation conditions become a prerequisite. In the current study, attempts were made for cultivation of recombinant strain of *Synechococcus elongatus* PCC 7942 from 1L to 100L scale under natural light regime using closed tubular reactor systems. The strain was engineered for heterologous production of ethylene by overexpressing ethylene forming enzyme (*efe*) gene. Our studies successfully demonstrated cultivation of transformants with ethylene productivity of 1.57 ml L⁻¹ h⁻¹ A_{730}^{-1} using vertical air-lift photobioreactor under outdoor cultivation regime with natural dynamic light conditions (max. $1200 \pm 300 \,\mu$ mol m⁻² s⁻¹). Further, inorganic carbon supplementation in the form of bicarbonate was found to improve the cell sustenance and biomass production at higher scales, surpassing typical inhibitions posed by physico-chemical attributes during scale-up. Overall, our investigation serves as the holistic foundation for future research in the field of scale-up cultivation of engineered cyanobacteria.