Henry T Bedoya et al., J Bioremediat Biodegrad 2017, 8:5(Suppl)
DOI: 10.4172/2155-6199-C1-008

Production of microalgae biomass: Upscaling of five commercial microalgae strains in greenhouse at northern latitudes

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Statement of the Problem: The feasibility of upscaling of microalgae biomass at Norwegian latitudes in greenhouse without artificial illumination nor extra heating as a future sustainable energy source has been evaluated.

Methodology & Theoretical Orientation: Two marine(m) and three freshwater(f) algae were cultivated in duplicate, from inoculum batch to upscale in polypropylene open Tray PhotoBioReactor (TPBR, 25 L). *Chlorella vulgaris(f), Dunaliella salina(m), Nannochloropsis oculata(m)*, cultivated for 63 days (20.06.12-23.08.12), and *Scenedesmus sp(f), Chlorella wild mix Årungen(f),* cultivated for 42 days (20.07.12-23.08.12), at semi-continuous operation system, enriched CO_2 air (3%) and prepared in situ, trifold nitrogen nutrition media (3N-BBM+Vit) and tap water, with volumes replenished when need. Effects investigated: 1. Irradiance and temperature on specific growth rate and daily growth. At 23°C *Scenedesmus* sp. grew faster at 0.05 h-1 and fivefold when doubling the irradiation energy input, meanwhile *Dunaliella salina*, reported 0.024 h^{-1} and 71.4% growth increase. 2. Outside weather condition in conjugation with irradiation and temperature on oxygen evolution (dissolved, DO) showed that cloudy days generated 31% more DO with 2.64 times less PAR irradiation than sunny days. 3. Optimized Dilution (D) and Mixing (M) regimes on biomass productivity (P) of marine algae increased by 60%. 4. Irradiance (I) on Photosynthetic Efficiency (PE), for marine strains 61% lower irradiance gave 4 times higher PE, and for freshwater strains, a four times lower irradiance gave 4.6 times higher PE. 5. Irradiance on areal CO_2 fixation rate, the mean CO_2 fixation rate was 55.44 $gCO_2m^{-2}d^{-1}$, which is 2.6 times higher values than found by Hulatt (2011). 6. Outdoors weather conditions on TPBRs energetic efficiency found the overall Irradiation Utilization Efficiency (IUE) provided by the TPBR. *Nannochloropsis oculata*, performed best with 1.37 gMJ-1, and optical pathway 0.09 m.

Conclusion & Significance: A cost-efficient greenhouse microalgae biomass production at northern latitudes shows great potential as sustainable energy supplier e.g., raw ingredients for nutraceutical and animal feed industries.

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