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Characterisation of a simple 'hanging bag' photobioreactor for low-cost cultivation of microalgae

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Abstract:

BACKGROUND: Microalgae are a diverse group of photosynthetic microorganisms of significant interest to the biotechnology industry, either as a sustainable source of natural compounds, or as light-driven cell factories to produce recombinant metabolites and proteins. Their ability to utilise light, CO2, and basic nutrients leads to a simple and low-cost phototrophic cultivation process. This is particularly relevant to low- and middle-income countries, all of which require a cultivation system that is cheap, technically simple to operate, readily scalable, and can meet basic Good Manufacturing Practice requirements. A disposable 'hanging bag'-type photobioreactor operated as a bubble column fits these criteria.
RESULTS: In this study, the characterisation and design modifications to improve the performance of a 15 L hanging bag is reported. The bubble behaviour using different sparger designs was investigated together with gas hold-up, mixing time, and mass transfer coefficient of CO2. A gas flow rate of 5 L min−1 using a new sparger design and a modified height-to-diameter ratio of the bag led to a two-fold improvement in algal biomass productivity when culturing the green microalga Chlorella sorokiniana. The cultivation of a luciferase-expressing Chlamydomonas reinhardtii strain in the modified hanging bag also demonstrated an 11% increase in luciferase content.
CONCLUSION: This is the first attempt to characterise this simple hanging bag system that brings the industry-favoured singleuse bag concept into the research field of photobioreactor technology. The hanging bag with modified sparger and dimensions improves microalgal biomass productivity and demonstrates the potential of simple and low-cost systems for microalgal cultivation.

Keywords: microalgae, single-use photobioreactor, hanging bag, bubble column, phototrophic cultivation