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Metabolomic profiles of tropical *Chlorella* and *Parachlorella* species in response to physiological changes during exponential and stationary growth phase

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ABSTRACT

Chlorella species are known to be potential algal candidates for biodiesel production due to their ability to store high lipid content and their natural metabolic versatility. An understanding of physiology and metabolic capacity of indigenous *Chlorella* strains is potentially useful for future biodiesel production in the tropical environment. The primary aim of this study was to assess the photosynthetic performance, biochemical content and fatty acid composition of *Chlorella* and *Parachlorella* species grown and harvested during exponential (EX) and stationary (STA) growth phases in batch culture. Physiological data suggested that the cells responded to these conditions by initiating lipid accumulation when growing from EX to STA phase. An increase of lipid and saturated fatty acids (SFA) contents was observed in STA, although this trend was not consistent across the different strains of *Chlorella* and *Parachlorella* species. To gain further insights into metabolomic adaptation at different growth phases, metabolites were extracted from selected *Chlorella* and *Parachlorella* strains at EX and STA phase. These metabolic profiles were analysed resulting in identification of 74 metabolites. Metabolomic profiles of *Parachlorella* showed that there was an increase in recycling of amino acids and nucleic acids at STA phase. The metabolites associated with photosynthesis and chlorophyll biosynthesis were also repressed while carbon sources were channelled into lipid biosynthesis. Meanwhile, *Chlorella* species showed a similar response in carbon allocation for lipid accumulation with lesser influence on amino acid and chlorophyll degradation. Therefore, *Chlorella* and *Parachlorella* species exhibit different changes in metabolic responses at different growth phases, which may be the result of metabolic adaptations arising from their evolutionary plasticity. Overall, our results expand the current understanding of metabolomics of *Chlorella* and *Parachlorella* species and provide valuable insights into their lipid accumulation during different stages, which is important for optimization of lipid productivity for biodiesel production.

1. Introduction

The green algae in the genus *Chlorella* are a large group of eukaryotic, unicellular, and photosynthetic microorganisms that are widely distributed in freshwater and marine environments. *Chlorella* is a photoautotroph and has been used as a model system in the early research on photosynthetic CO_2 fixation. They are also among the very few algal groups capable of using organic carbon for heterotrophic growth, which endows *Chlorella* with the metabolic flexibility to respond to environmental perturbation. Because of its robustness and various metabolic capacities, *Chlorella* has aroused a widespread interest as a potential feedstock for industrial biomass production [1],

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