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Effects of temperature and nutrient regimes on biomass and lipid production by six oleaginous microalgae in batch culture employing a two-phase cultivation strategy

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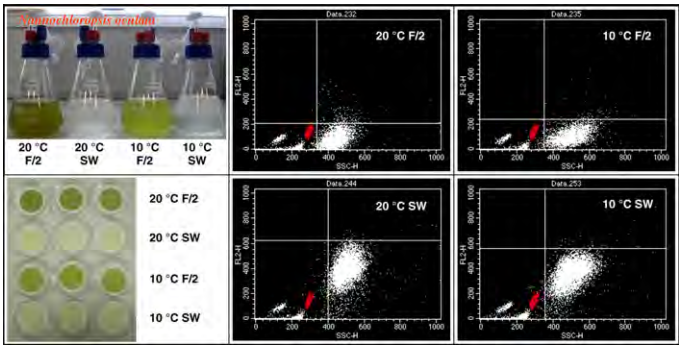
HIGHLIGHTS

- Nutrient and temperature interactively affect growth but no additive effect on lipid accumulation of oleaginous microalgae.
- Growth rate and fatty acid content were negatively correlated.
- Triacylglycerol accumulation was a default response to environmental stress.
- Stress conditions led to reduced fatty acid unsaturation.
- Nutrient limitation was the most critical factor affecting lipid metabolism.

GRAPHICAL ABSTRACT



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ABSTRACT

Commercial success of algal-based biofuels depends on growth characteristics and lipid metabolism of the production species. The oleaginous microalgae, *Thalassiosira pseudonana*, *Odontella aurita*, *Nannochloropsis oculata*, *Isochrysis galbana*, *Chromulina ochromonoides*, and *Dunaliella tertiolecta*, were cultivated under a matrix of two temperatures (10 and 20 °C) and two nutrient regimes (deplete and replete). For all species, a strong negative correlation between growth rate and lipid content was observed. Multiple stressors have no additive effect on lipid accumulation. Total oil content (fatty acid methyl esters, FAMEs, pg cell^{-1}) was increased more by nutrient limitation than by temperature stress. In response to nutrient stress, *N. oculata* emerged as the most robust species with an increase in lipid accumulation of up to three to four-fold compared to the accumulation under nutrient sufficient conditions. Although stress conditions led to reduced fatty acid unsaturation in most taxa due to increased triacylglycerol (TAG) production, a high proportion of eicosapentaenoic acid (EPA) was maintained in *O. aurita*.

1. Introduction

Microalgae are particularly attractive as feedstock for the production of lipid-based biofuels since they are adapted to grow over a wide range of environmental conditions with, in many cases, short doubling times (Mata et al., 2010). Furthermore, their survival strategies are often underpinned by the presence of diverse and unusual patterns of cellular lipids and their capacity to modify lipid metabolism in response to changes in environmental conditions. Both biomass production and lipid accumulation are limited by a variety of factors, of which nutrients (e.g. Chen et al., 2011; Feng et al., 2011; Mairet et al., 2011), temperature (Fuentes-Grünewald et al., 2012; Li et al., 2011a) and irradiance (Hu et al., 2008 and

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