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Kinetic modeling of photoautotropic growth and neutral lipid accumulation in terms of ammonium concentration in *Chlamydomonas reinhardtii*

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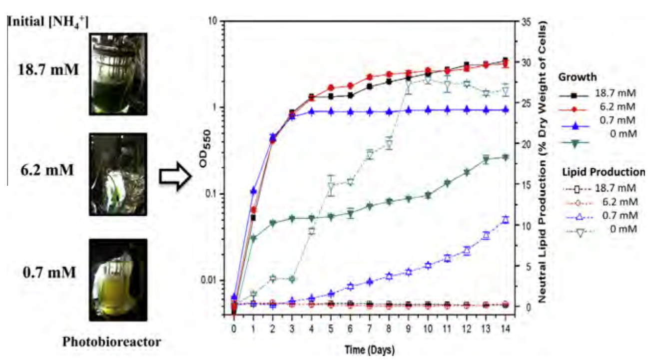
HIGHLIGHTS

- ▶ Nitrogen depletion increases lipid production and limits growth effect.
- ▶ Neutral lipid production rate is indirectly related to biomass growth.
- ▶ Model equations satisfactorily predict cell growth and lipid production.
- ▶ Growing algae in different nitrogen concentrations is beneficial for scale up.

GRAPHICAL ABSTRACT



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ABSTRACT

This study focuses on the cell growth and the neutral lipid production modeling of *Chlamydomonas reinhardtii* in terms of different ammonium concentrations. Autotrophy was maintained during growth in a double walled bioreactor, using Tris Phosphate (TP medium) with only CO_2 and NH_4Cl as sole sources of carbon and nitrogen, respectively. Nitrogen depletion results in an increase in neutral lipid production with an indirect effect on the growth of algal cells. Modified Baranyi–Roberts and logistic equations were used to describe the cell growth whereas Luedeking–Piret equation was used for neutral lipid production kinetics. Sensitivity analysis shows that the model equations satisfactorily predict the cell growth and lipid production. Based on the mathematical model predictions, growing algal cells in higher ammonium containing medium initially and switching to low ammonium containing medium in a later stage may result in elevated amounts of lipid production, which may be used for scale up and commercialization.

1. Introduction

Microalgae have positioned themselves in recent years in both academia and industry for their potential in commercial production of biofuels and byproducts. Though the growth of *Chlamydomonas reinhardtii* has been well developed and modeled under various growth conditions (Eriksen et al., 2007; Zhang et al., 1999), neutral lipid-triacyl glycerols (TAGs) metabolism/production is poorly studied. The biosynthetic pathways documented are based on *in silico* studies, which include similarity searches for genes encoding enzymes (functional homology to bacterial orthologs) that are involved in anabolic reactions of lipid biosynthesis (Riekhof et al., 2005). It is also documented that there is a distinct pathway in *C. reinhardtii* in which diacyl glycerol (DAG) in the chloroplast is converted to TAG's (Fan et al., 2011). In another study, TAG was found competitively produced with respect to starch biosynthesis (Li et al., 2010). However, complemented strains of *C. reinhardtii* starchless mutants exhibit a significantly higher amount of both starch and TAG under nitrogen-deprived

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