MICROALGAL LIPIDS: BRIDGING THE YIELD GAP

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ABSTRACT

Introduction
"The realisation of economic and sustainable production of microalgal bulk lipids requires enhancement of the lipid yield" is a frequently made statement. But what is the upper limit of microalgal lipid productivity, and how big is the gap with current practice? The present work answers these questions and explores the potential of strain selection, strain improvement and bioreactor design and operation for bridging the lipid yield gap.

Methods
First, the theoretical maximum lipid yield on light was estimated using genome-based stoichiometric modelling of the microalgal metabolism. This was then compared with current best practice, to quantify the lipid yield gap. Subsequently, potential yield gains were determined through strain selection and through controlled-photobioreactor studies on various cultivation modes and cultivation conditions, including temperature, pH and light intensity. Finally, a *Scenedesmus obliquus* starchless-mutant was developed and evaluated for improved lipid productivity.

Results
The theoretical maximum lipid yield on light, estimated at 1.1 gram triacylglycerides per mol visible-light-photons, is about 10-fold higher than what is currently achieved in year-round outdoor production at demonstration scale. An approximate 3-fold reduction of this yield gap was possible when optimal wild type strains (*Scenedesmus obliquus*, *Chlorella zofingiensis* and *Neochloris oleoabundans*) were used, combined with optimal photobioreactor design and operation. Another 1.5-fold reduction was achieved through improved carbon partitioning towards lipids in the starchless *S. obliquus* mutant.

Conclusion
There is large potential to improve the lipid yield of outdoor microalgal cultures. This work shows how a multidisciplinary approach can substantially bridge the lipid yield gap.