A newly designed closed, stirred-tank photobioreactor system for producing mass densities of dinoflagellate and other selected microalgae

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ABSTRACT

As more marine products are being discovered from various microalgae, researchers must overcome the problem of producing mass densities for the harvesting of biologically active material while using the fewest resources and space possible. Unfortunately, little is known on the parameters necessary for growing sensitive dinoflagellate microalgae in mass culture. Through a collaboration between IKA Works, Inc. and the Algal Resources Collection at the MARBIONC facility (University of North Carolina Wilmington), a 10 liter, fully autonomous photobioreactor was created and proven successful in producing elevated mass densities of biological material. Using cultures of Amphidinium gibbosum, Alexandrium ostenfeldii/peruvianum, and other dinoflagellate microalgae, we have successfully and reproducibly generated an equal wet pellet weight in one ten liter photobioreactor as we have in eighty liters of static culture. Cellular counts of A. gibbosum reach up to 300 million cells per liter, producing an average wet pellet weight of 22-40 grams from one ten liter photobioreactor. The IKA photobioreactor is flexible and easily adaptable. It reduces the footprint for growing high densities of algae and can be used directly as a low-cost experimental instrument for researchers, teachers, and industry to determine optimal growth conditions for the variety of algae studied.

INTRODUCTION

Bioactive materials originating from dinoflagellate microalgae are increasing in demand as researchers discover their use as natural products for pharmaceuticals and biomedical studies (2). Chemically synthesizing these compounds has proven difficult or impossible, and the lack of commercially available biotoxins creates a need for researchers to discover how to produce mass densities of dinoflagellates (1). Static mass culture typically produces a low biomass yield and utilizes an extensive amount of space and resources. Due to their sensitive nature (1), dinoflagellates used in previous bioreactors failed to grow well, resulting in limited biomass (1).The culturing of dinoflagellates requires species-specific control over environmental parameters, including:
shear stress due to mixing and gas bubbling (2);
light intensity and distribution (3);
controlled pH (3);
gas absorption (3);
controlled temperature (3);
and a sterile environment (3).
In this study, we determined the effectiveness of using a closed, stirred-tank photobioreactor, created by IKA Works, Inc., compared to a static 10 liter carboy in producing mass densities of dinoflagellate biomass. A 10 to 100 fold in biomass for the same 10 L value was achieved in the IKA PBR 10 compared to static culture.

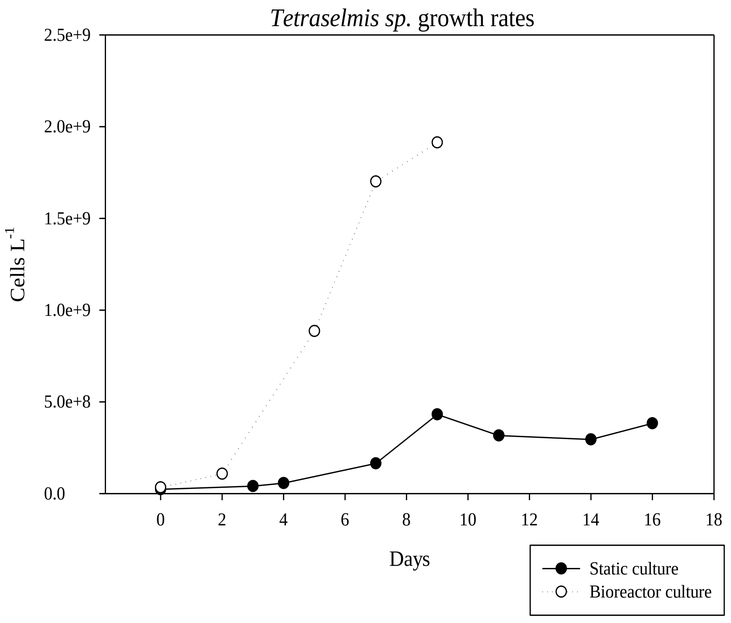

Fig. 1 Growth rates of a *Tetraselmis sp.* in a bioreactor compared to static culture

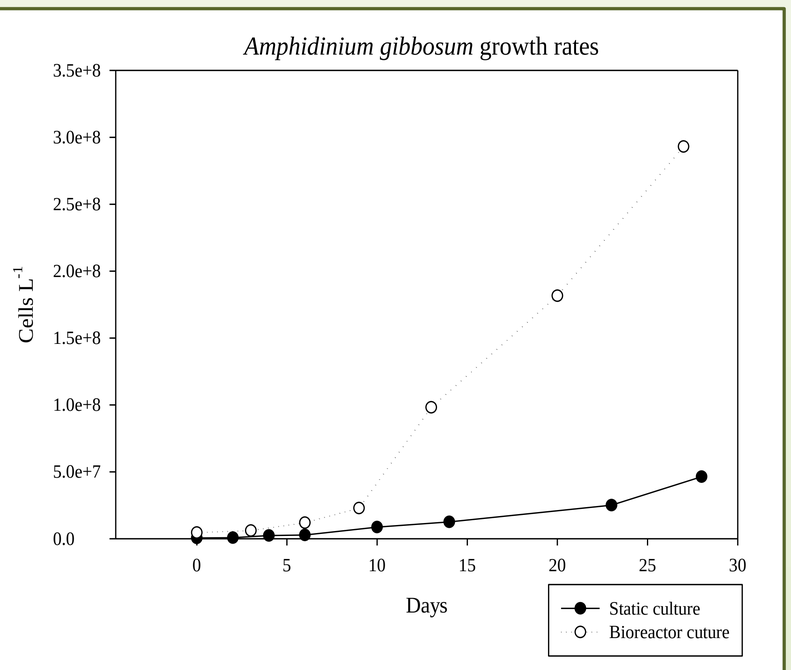

Fig. 1 Growth rates of *Amphidinium gibbosum* in a bioreactor compared to static culture

BIOREACTOR GROWING PARAMETERS:

Stir speed:	30 rpm; continually
Lighting intensity:	10%, increased to 20% after 5 days; on at 0600, off at 2200 hours
Temp.:	22°C
pH:	CO_2 on at 8.6; off at 8.4 O_2 on constantly

BIOREACTOR GROWING PARAMETERS:

Stir speed:	40 rpm; continually
Lighting intensity:	20%; on at 0600, off at 2200 hours
Temp.:	22°C
pH:	CO_2 on at 8.6; off at 8.4 O_2 on constantly

SUCCESSFULLY RUN GENERA

Dinophyceae:
Alexandrium
Amphidinium
Coolia
Karenia
Prorocentrum
Scrippsiella
Vulcanodinium

Raphidophyceae:
Chatonella

Prasinophyceae:
Tetraselmis

Prymnesiophyceae:
Prymnesium

Cyanophyceae:
Synechococcus

Bacillariophyceae:
Pseudo-nitzchia

Cryptophyceae:
Rhodomonas

NEXT STEPS

More species tested

100 L PBR

Semi-continuous runs

ACKNOWLEDGMENTS

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