Cultivation of marine microalgae, native of the Ionian Sea, in open raceway pond - Production of high-value compounds

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INTRODUCTION

In recent years there is a great interest for high added value bioproducts derived from marine microalgae. These valuable metabolic compounds (e.g. lipids, carbohydrates, pigments, proteins), are well known for their potential use in biotechnological applications in various fields, such as pharmaceuticals, cosmetic products, human and animal nutrition and the production of renewable energy sources. In this work four different marine microalgae species (isolated from coastal areas of the Ionian Sea) (Figure 1) were cultivated in pilot-scale raceway pond with the aim to examine their biomass production and its composition, in order to assess their use in various biotechnological applications.

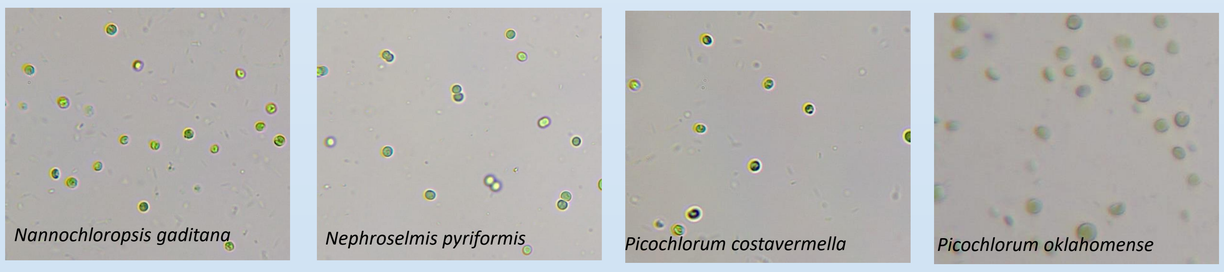

Figure 1. Microscopy image of marine microalgae cultures (x40).

MATERIALS AND METHODS

A paddle wheel, open, raceway pond photobioreactor of 40 L operating volume was tested for the cultivation of four different marine microalgae species (isolated from coastal areas of the Ionian Sea), under non aseptic conditions. Specifically, the strains *Nephroselmis pyriformis, Picochlorum costavermella, Picochlorum oklahomense* and *Nannochloropsis gaditana* were examined. Initially, stock cultures of strains were gradually scaled up from 100 ml (using flasks of volume 250ml) (Figure 2a) to 6L aquariums (Figure 2b) with the aim to inoculate the raceway pond (Figure 2c). It should be mentioned that the growth medium was sterile artificial seawater of salinity 33 ‰. In all experiments the pH was remained at the value of about 8.5, the temperature was 23°C±1°C, while continuous illumination (2000-2500 lux) was employed from three LED lamps. Also, the culture was circulated in the pond using a double 4-bladed paddlewheel driven by an electric motor rotating at 35 rpm.

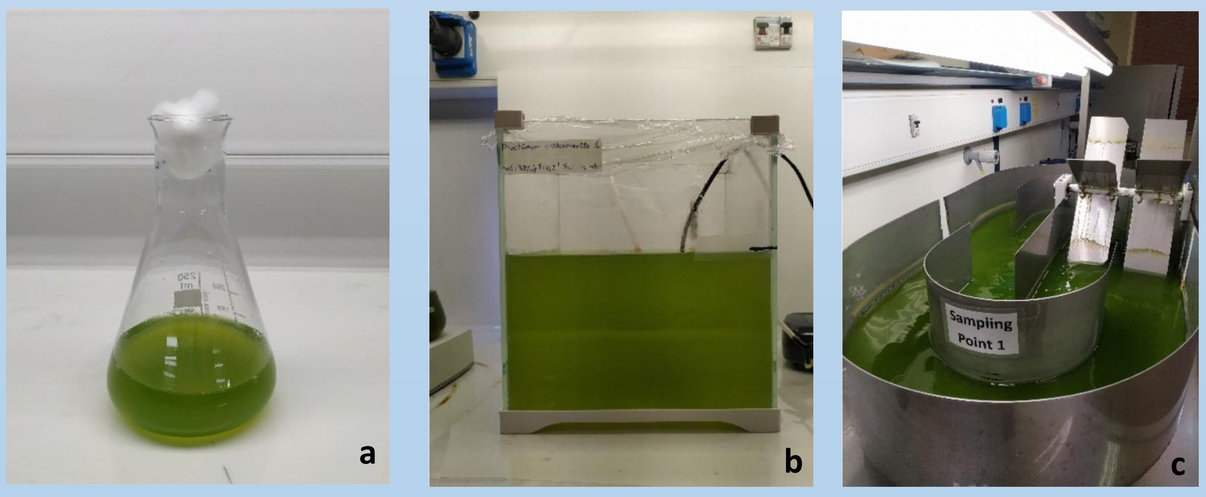

Figure 2. Marine microalgae cultivation in different scaled photobioreactors: a) Erlenmeyer flask 250ml, b) glass aquarium 6L, c) stainless steel open raceway pond 40L.

RESULTS

Biomass growth was examined for all the above-mentioned microalgae strains, for a period of 19 days (Figure 3). *N. pyriformis* and *P. costavermella* presented similar final biomass concentration, 419.1±79.9 mg/L and 405.7±0.2, respectively, while *N.gaditana* reached a lower value, that of 359.5±42.7 mg/L. An even lower value (212.9±11.4 mg/L) was presented for *P. oklahomense*. Lipid content was varied greatly by species, with values of 30.7±4.5, 64.7±0.3, 75.2±5.9 and 28.3±3.8 mg/L, for *N. pyriformis*, *N. gaditana, P. costavermella* and *P. oklahomense,* respectively. The final produced biomass was also characterized for its protein, polysaccharide and amino acid content, in order to assess the use of biomass in various biotechnological applications (Table 1).

RESULTS

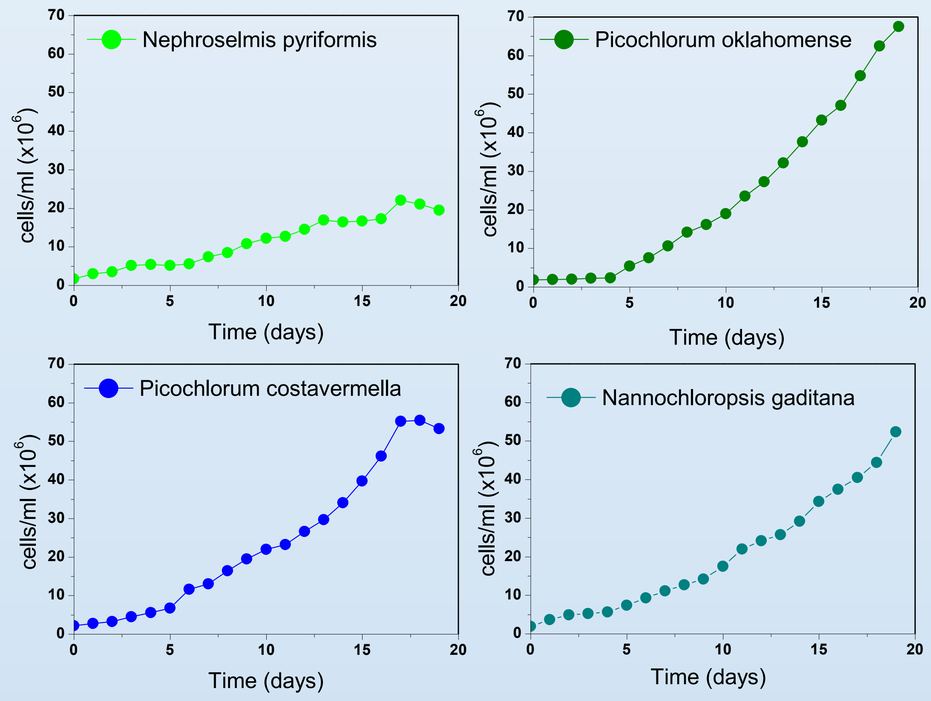

Figure 3. Kinetics of growth of *Nephroselmis pyriformis, Picochlorum costavermella, Picochlorum oklahomense* and *Nannochloropsis gaditana* in raceway pond (40L).

Table 1. Final cell concentration, Final biomass concentration and biomass biochemical composition for all strains tested

	N. pyriformis	*P. oklahomense*	*P. costavermella*	*N. gaditana*
Final cell concentration (cells/ml (x10^6))	19.5	67.5	53.3	52.4
Final biomass concentration (mg/L)	419.1	212.9	405.7	359.5
Polysaccharide content (% d.w.)	14.3	14.7	7.7	9.0
Total protein content (% d.w.)	63.5	47.3	47.3	47.9
Amino acid content (% d.w.)	28.7	27.8	20.6	19.6
Lipid content (% d.w.)	7.3	13.2	18.5	18.3

CONCLUSIONS

- *Picochlorum oklahomense* growth proceeded faster than *Nephroselmis pyriformis, Picochlorum costavermella,* and *Nannochloropsis gaditana* reaching the maximum cell density of 67.5 x10^6 cells/ml.
- *Nephroselmis pyriformis* reached the highest final biomass concentration (419.1 mg/L) compared to other three strains. Its biomass was rich in protein (63.5%) and amino acid content (28.7%), while presented the lowest lipid content (7.3%).
- Amino acid analysis indicated that *Nephroselmis pyriformis* had high content of Lysine, Methionine and Threonine, therefore its biomass can be considered a highly nutritional ingredient suitable for aquafeed production.
- *Picochlorum costavermella* and *Nannochloropsis gaditana* presented the highest lipid content (18.5% and 18.3%. respectively). Fatty acid (FA) profile of total lipids is required to determine several nutritional parameters of lipids.
- All above four marine microalgae species (isolated from coastal areas of the Ionian Sea) should be cultivated in large-scale units, producing biomass suitable in various biotechnological applications.

ACKNOWLEDGEMENT

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