IITB-Monash Research Academy

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Effect of high CO_2 concentrations on the growth and macromolecular composition of a heat- and high-light–tolerant microalga

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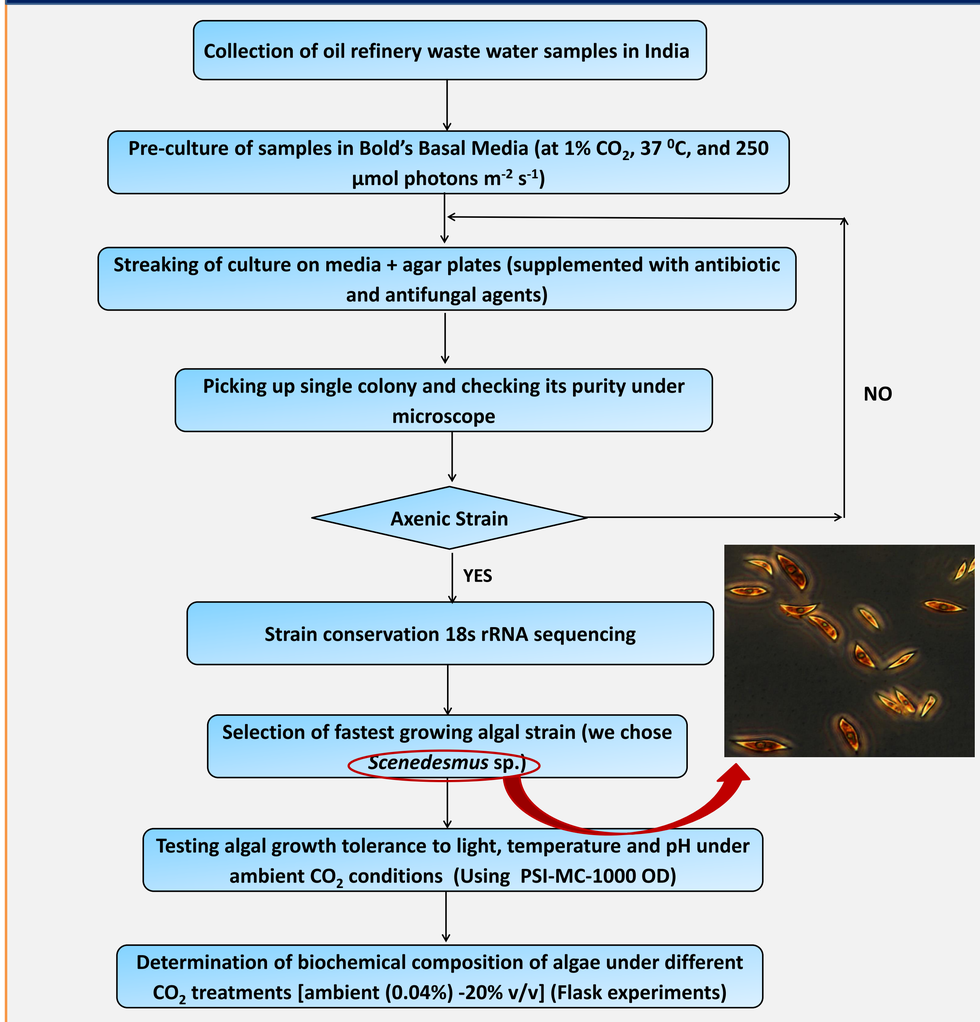
OVERVIEW

- The potential hazards associated with the increasing concentrations of CO_2 in the biosphere has led to increased investigations on CO_2 amelioration technologies.
- Biological processes that involve algal photosynthesis for CO_2 utilization have attracted great attention as they are 10-50 times more efficient in bio-fixation of CO_2 than even the fastest growing terrestrial plants.
- Our research focuses on isolating and characterizing microalgae that can efficiently convert CO_2 emissions, which are present in industrial flue gases, into organic matter.
- We assume that microalgae growing in ponds situated in the locality of any industry are more likely to tolerate environmental conditions prevalent in that area, hence we collected water samples from the effluent treatment unit of an oil refinery located in the northern part of India and carried out our experiments.

METHODOLOGY



Cells of ***Scenedesmus* sp.** were acclimated at each CO_2 treatment for two growth cycles (three days each) before starting an actual experiment .

During each experiment samples were collected at two different growth stages :

at 72h = late exponential phase and

at 120 h= late stationary phase

All data are the mean of 3 independent cultures +/- SE

PHYLOGENETIC PLACEMENT OF OUR STRAIN

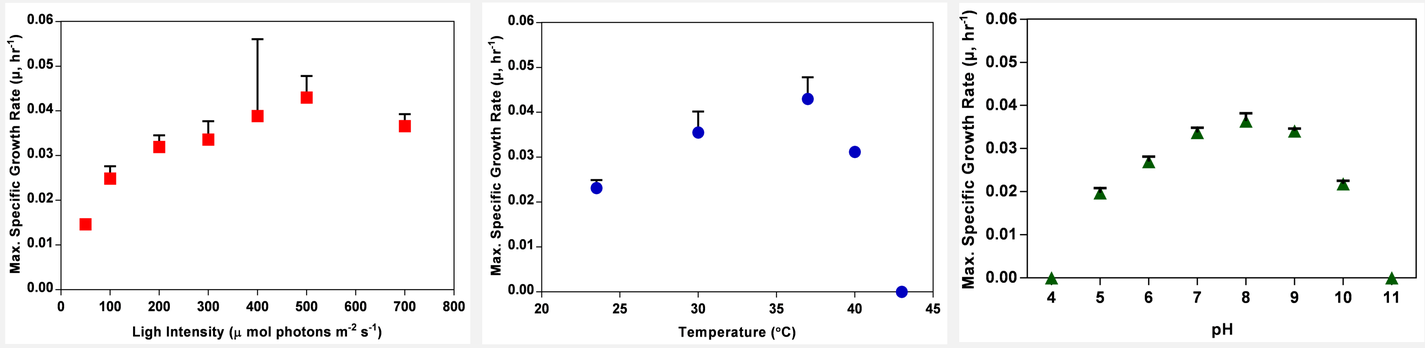
Neighbor joining method (based on distance matrix data) was used to construct the phylogenetic tree using Mega 6.0 software.

REFERENCES

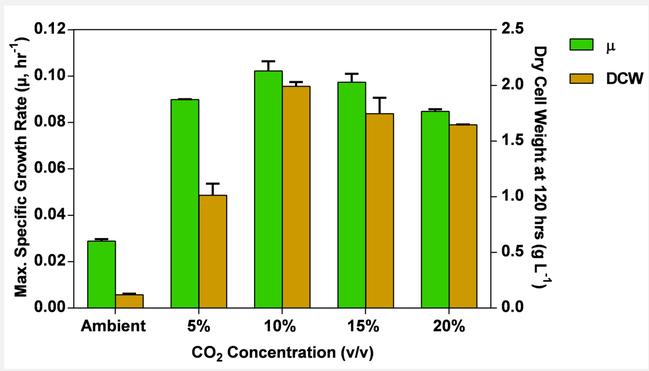
1. DuBois M, Gilles KA, Hamilton J., et al (1956) Colorimetric method for determination of sugars and related substances. Anal Chem 28:350–356
2. Lowry OH, Rosebrough NJ, Farr AL, Randall RJ (1951) Protein measurement with the Folin phenol reagent. J Biol Chem 193:265–275
3. Chen W, Zhang C, Song L, et al (2009) A high throughput Nile Red method for quantitative measurement of neutral lipids in microalgae. J Microbiol Methods 77:41–47

EXPERIMENTAL RESULTS

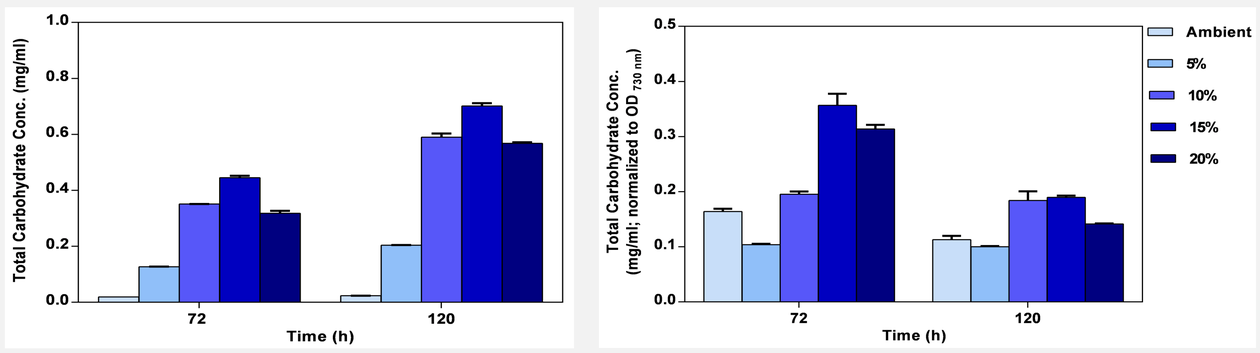
Effect of Light (50-700 µmol $m^{-2}s^{-1}$), Temperature (23.5–43^0 C) and pH (4-11)



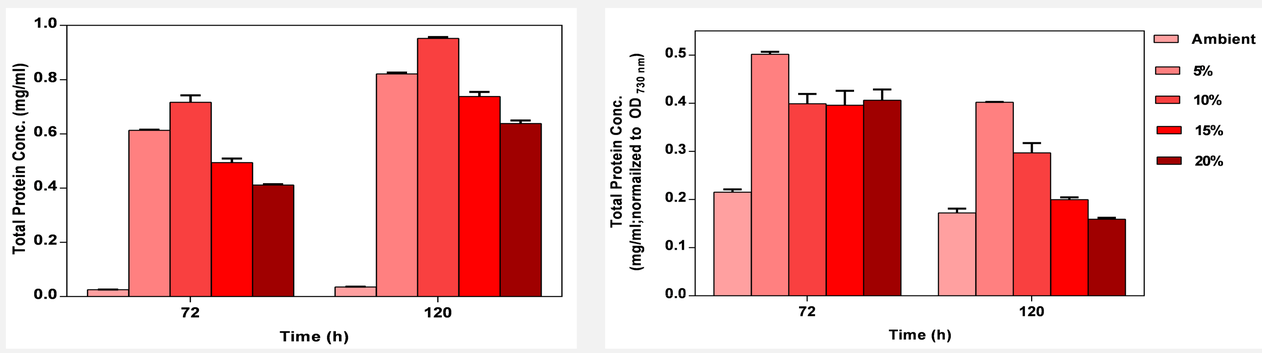
Maximum Specific Growth Rates (µ) and Maximum Dry Biomass (DCW, at 120 h)



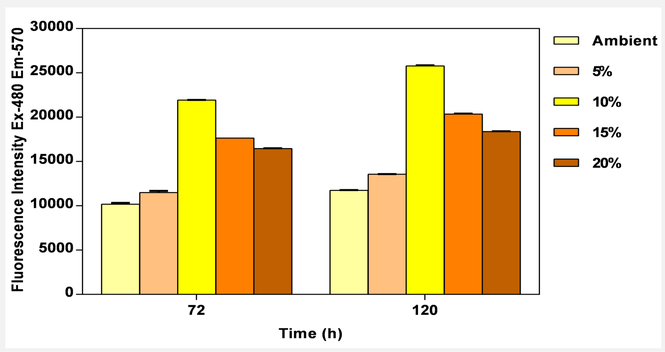
Carbohydrate Content [1] under Different CO_2 Treatment



Protein Content [2] under Different CO_2 Treatment



Neutral Lipid Content (fluorescence emission of Nile Red stained cells)[3] under Different CO_2 Treatments



CONCLUSION

- The screening for high-temperature, intense-light and high-CO_2–tolerant micro-algal strains was successful.
- The gross composition of the alga changed, depending upon the type/ severity of stress as well as growth stage.
- The growth saturating light intensity for our strain was quite high (tested up to 700 µmol m^{-2} s^{-1}) and the maximum growth rate was observed at 500 µmol m^{-2} s^{-1}.
- The strain showed a broad range of temperature tolerance up to 40 ^{0}C with the maximum growth rate at 37 ^{0}C.
- It also showed a good growth profile in the pH range of 5-10, with the optimal growth rate at pH 8.0.
- In terms of biomass, the most favorable CO_2 concentration for our alga was 10% (v/v), while the maximum carbohydrate, protein and lipid content were found in 15%, 5% and 10% CO_2 treatment respectively.
- These preliminary results show that it is a very promising strain for its exploitation in mass culture for CO_2 remediation.

FUTURE DIRECTION

This strain should be tested for tolerance to other flue gas components such as nitrogen oxides (NO_x) and sulfur oxides (SO_x)

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