A COMPREHENSIVE ANALYSIS ON CARBON ASSIMILATION AND LONGEVITY OF ALGAE IN INDUCED STRESS CONDITION

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Abstract : Algae are heterogenous group of unicellular, prokaryotic/eukaryotic and photosynthetic organism having high economic potential. Oscillatoria sp. isolated from a highly Carbon polluted area is studied for its hydrocarbon storage, CO2 fixation and lipid accumulation ability. The carbohydrate 116.34 mg/mL, protein 31.45 mg/mL, lipid 8.30 mg/mL content of the strain algae were estimated. Also the longevity of algae in carbon dioxide bubbled medium was noted for 21 days to know the survival of algae in 100% CO2. This study shows the change in environmental factors, especially stressed physiological condition has direct impact on positive cellular lipid accumulation.

IndexTerms **- Algae, Carbonate deficiency, nitrate deficiency, algal lipid.**

I. INTRODUCTION

Photosynthetic prokaryotes have a wide prospective in biotechnological industry. It has been widely cultivated for food, fuel, fodder, fertilizer, pharmaceutical and cosmetics for secondary metabolite and algal oil extractions. It also checks the release of CO2 to the atmosphere. Its high growth rate and multi potential drew the modern scientific world to explore more from these ancestral photoautotrophs. Microalgae are more efficient than terrestrial plants in photosynthesis even under polluted conditions, recycle the pollutant CO2 from the atmosphere and reduce the Carbon footprint by enhancing a sustainable environment. (Keyuri Mokashi et.al, 2016.)

CO2 emission to the atmosphere should be below 0.05% and its hoisting will lead to global warming. Some microalgal species like Chlorella, Spirulina and Dunaliella have been proved to be CO2 sequestrating species and also have some commercial values. Growth of microalgae and their physiological compositions depends on the environmental conditions such as temperature, external nutrients, light, pH etc. (Guieheneuf et al 2008). The present study is to evaluate the efficiency and growth of selected microalgae from extreme condition in static variently nutrient conditions.

II. MATERIALS AND METHODS

2.1 Isolation and screening of CO2 fixing microalgae

Algal samples were collected and cultured in optimum environmental conditions in the laboratory (temperature 25+ 2oC, light intensity 1000 lux, pH 7-7.8 and chemical nutrients). Algal samples were cultivated in mineral medium devoid of carbon source at 28 + 2oC at proper light source for 1 week and sub-cultured after 7 days. The culture broth was spread over different solid media, re-cultivated and purified. The cultures were then screened for their ability to tolerate higher amounts of CO2 by aerating the culture broth with 100% CO2 for 2-4 days using a controlled aerator. Biomass concentration was measured by UV-vis spectroscopy at a wavelength of 680 nm. Microalgal strain with higher OD, i.e., noble growth and maximum day of surviving was selected for further studies.

2.2 Determination of microalgal cell concentration and Ph

The cell concentration of the culture was determined regularly by measuring optical density using UV-Visible spectrophotometer. The dry cell weight of the algal mass was obtained by filtering 10 ml aliquots of the culture lyophilized, through previously weighed eppendorf tubes. Each loaded filter was dried at -70oC until the weight was invariant. The dry weight of the blank filter was subtracted from that of the loaded filter to obtain the algal dry cell weight. The pH of the samples is proportionally analyzed using a standard pH meter.

2.3 Determination of the biochemical composition of microalgae

Anthrone method is used to estimate Carbohydrate and Lowry's method for protein estimation (Sadasivam and Manickam, 2008). Total lipid was determined by using Folch method (Folch et. al., 1951).

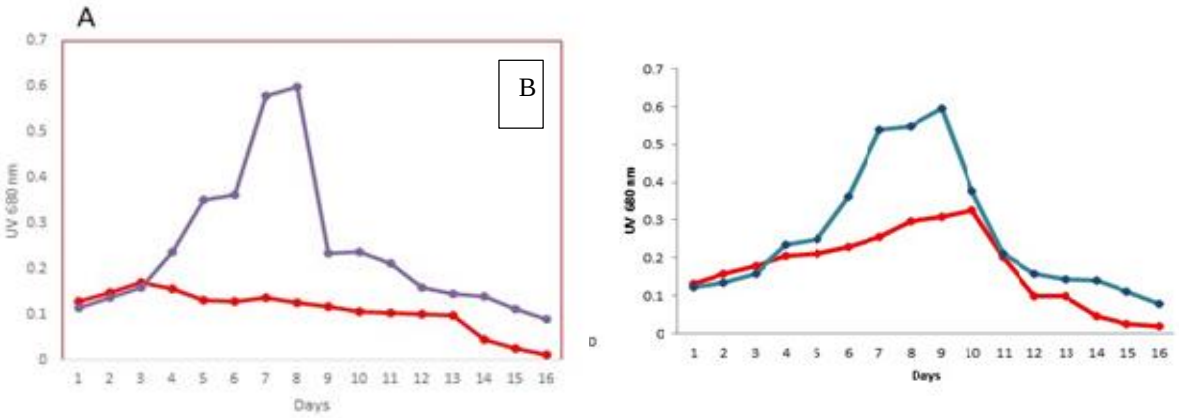
III. RESULTS AND DISCUSSION

3.1. Isolation of microalgae

Out of the total algal colonies isolated in the lab conditions, Oscillatoria sp. showed rapid growth and multiplication in the experimental setup. The morphological identification was done using a standard manual for identification.

3.2. Biomass concentration

The isolated algal sample have a dry biomass of about 6.03+ 0.64 g/ml and that of control algal mixed sample is 3.67 + 0.3 g/ml. The algal biomass growth was analyzed by a haemocytometer and the graphical representation for the growth rate per day according to the spectrophotometric reading was given in Fig.1.



--growth curve of algae --growth curve of mixed algae

Fig.1: Comparison of Growth curve for (a) algal samples, (b) in CO2 bubbled samples.

3.3 Biochemical analysis

The cellular content of carbohydrate, protein and lipid were expressed as percentage of dry weight. All biochemical estimations were done after the 21st day of incubation. The comparative data of algae grown in normal medium were shown as 116.34, 31.45, 8.30 mg/mL and for algae grown in CO2 were 163.23, 14.94 and 22.31mg/mL in order of carbohydrate.

The carbohydrate content in algae was 116.34 mg/mL and for CO2 bubbled algal mixture 163.23 mg/mL. The sample collected from the polluted area showed better carbon assimilation property than the control sample. About 50% efficiency had been reduced and in lipid accumulation, the algae result comparative good yield. However, prolonged CO2 pumping lead to cell death after 24 days. Microalgae have unique sense to adapt to environmental changes like light, temperature and nutrient ability. If the amount of CO2 is high in the external environment the expression of Carbonic anhydrase was suppressed and induced in CO2 depleted medium. Also microalgae have the ability to use excess carbonate as an energy source in photosynthetic pathways. In its limitation the accumulation of carbonates will be as polysaccharides mainly as exopolysaccahrides (Prabhakaran and Ravindran, 2012). A typical response to nitrogen limitation is discoloration of the cells (decrease in chlorophylls) and accumulation of additional organic carbon compounds such as polysaccharides and certain oils. Microalgae are capable of accumulating oil contents more than 20% of their biomass. This high amount of lipid storage in their biomass can be applied in bioprocesses to produce alternative oils for biofuel manufacture. The oil globules in the microalgae may be a result of habitualization in extreme condition.

IV. CONCLUSION

Microalgal sp. obtained from the polluted area shows more carbon assimilation property than the algal sample nurtured in the lab condition. The experimental setup shows it is mainly due to carbon stress and the quantity of gaseous carbon pumping into the open system. Also CO2 concentration influences the fall of pH to maintain it during the course of an experiment. The photosynthetic carbon assimilation exceeds the carbon demand for growth, leading to an increase in carbohydrates. It also stimulates the physiological, chemical multiplication of the microalgae. Typical light intensity requirements of microalgae are less, but its photosynthetic efficiency is greater compared to higher plants. Light cycles play a determinant role in photosynthetic as well as the growth rate of microalgae. Although it is well known that the changes in molecular level, mainly in mRNA do not necessarily match the change in protein or enzyme activities. So the environmental stress plays a key role in enhancing the lipid and carbon productivity in the microalgae species.

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