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Carbon Sequestration Potential of Marine Microalgae

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Abstract

At present, the World experiencing a high level of pollution due to anthropogenic activity and increasing Carbon Dioxode (CO_2) level in the atmosphere, which resulted in the global climate change and global warming. The world population is increasing at the same time the technology has also developed. Various anthropogenic activities cause a major impact of rising temperature in the atmosphere. The researchers are focusing on the biological ways to reduce CO_2 in the atmosphere and suggested that marine microalgae is the most promising approach to capture the CO_2 in the atmosphere and microalgae have the potential to utilize CO_2 as a carbon source for growth. The microalgae biofixation process is the main concept of sequestration. This article discusses that CO_2 capture by microalgae is a most preferable method compared to employing other terrestrial plants for carbon capture.

Keywords: Climate change; Carbon capture; Microalgae, Carbon dioxide; Biofixation

Abbrevation: CO_2: Carbon Dioxide; V/V: Volume / Volume; DIC: Dissolve Inorganic Carbon; ATP: Adenosine Triphosphate; NADPH: Nicotinamide Adenine Dinucleotide Phosphate

Introduction

Marine ecosystems occupies the largest proportion in the Earth which is nearly 75% of the total area. It plays an important in the climate change. Like anyother ecosystems, the marine ecosystem also affected by global warming may be due to anthropogenic activities and increase in the concentration of atmospheric carbon dioxide. The ocean productivity also decreased by the impact of anthropogenic activities induced climate change. It altered the food web dynamics, reduced abundance of habitat-forming species, shifting species distributions [1]. High content of CO_2 in the atmosphere trigger the global warming and consequent climate shift which is the hazards for the sustainability of life on the earth. Different technology followed by CO_2 capture, but the biological methods still challenging technology due to low amount of biomass yield, high contamination, cost of maintenance, repair cost of fermentor and extraction of biomaterial is the major concern [2].

Microalgae is also one of the important microbial communities which are simple photosynthetic unicellular organisms. They can be either prokaryotes (cyanobacteria) or eukaryotes that can grow and live in harsh conditions because of its simple structure [3]. Carbon dioxide capture by marine microalgae is an important strategy to reduce temperature in the atmosphere. It is a pressing challenge for the humanity to to reduce gaseous emissions and their consequential climatic changes, greenhouse and global warming effects. The current level of CO_2 in atmosphere is approximately 280 parts per million (ppm) to 400ppm [4] The CO_2 is essential for growth of microalgae , and the lifetime of CO_2 is 50 to 200 years [5]. The CO_2 is contributing approximately 52% in total global warming [6]. Different microalgae have been studied for carbon dioxide fixation, among them Chlorella vulgaris received chief attention, which can tolerate high concentrations of CO_2, and high photosynthetic capacity. This microalgae can maintain high growth rate and CO_2 fixation rate in a wide range of CO_2 concentrations from 0.04 to 18% (v/v), can be considered as a good species to fix CO_2 [7].

There are many studies reported on the microalgal based CO_2 bio-mitigation, but there is lacking of literature review on the latest technologies on microalgal cultivation, which is mainly towards successful CO_2 bio-sequestration of atmospheric CO_2 and flue gas-containing CO_2. This opinion paper aims to summarize and discuss about the CO_2 bioconversion efficiency of microalgae species and the potential and future challenges of carbon capture.

Capturing CO_2 By Marine Microalgae

Microalgae can have the capability of to Dissolve Inorganic Carbon (DIC) from the aquatic environment in forms of CO_2, H_2CO_3, HCO_3, and CO. By contrast, terrestrial plants are much less diversified in the DIC assimilation [8]. The CO_2 captured by photosynthesis and converted into organic compounds powered by ATP and NADPH [9]. There are several photobioreactors used to cultivate the microalgae and the photobioreactor should be designed with specific parameters like carbon and nutrient level, light intensity, light/dark cycle, temperature, and pH. Some microalgae species possess heterotrophic metabolism and are able to grow in dark environments. The ability of microalgae to grow heterotrophically or mixotrophically is significant and important because this allows microalgae to sequester organic carbons present in waste waters, which can eventually emit to the atmosphere if broken down by bacteria [10]. The marine microalgae have the ability to convert almost 80% carbon dioxide into oxygen. The microalgae may be the better choice due to their small size and have high growth rate compared to other plant and also absorbs more CO_2 in a short time. It has the potential to reduce the toxicity of the water and utilize it as a nutrient factor for growth.

Conclusion

Microalgae are fast-growing microorganism with relatively high CO_2 biofixation rate compared to terrestrial plants. They provide so many co- products and renewable energy production. The CO_2 sequestration can be achieved towards environmental sustainability and economic feasibility. Microalgal-based CO_2 bio-sequestration is an innovative technology to bring significant advancement in CO_2 bio-mitigation aiming towards a global warming solution. In future multidisciplinary approach involving chemists, engineers and biologists would be beneficial for greater purposes.

Conflict of Interest

We declare that we have no conflict of interest.

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