



Microalgae: The Silent Saviors of Carbon Sequestration

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Abstract: *Microalgae have emerged as a promising solution in the global effort to mitigate climate change through carbon sequestration. Their ability to photosynthesize efficiently and proliferate makes them ideal candidates for capturing atmospheric carbon dioxide (CO₂). This article explores the mechanisms by which microalgae sequester carbon, examines their potential applications in various industries, and discusses the challenges and prospects of using microalgae for large-scale carbon capture.*

Introduction:

As atmospheric carbon dioxide (CO₂) concentration continues to rise, the need for effective carbon sequestration strategies becomes increasingly urgent. Traditional methods, such as afforestation and soil carbon storage, face limitations in terms of scalability and efficiency. In recent years, microalgae have gained attention as a potential game-changer in the field of carbon capture. These microscopic organisms are not only capable of photosynthesizing more efficiently than terrestrial plants, but they also possess the ability to thrive in a variety of environments, including freshwater, marine, and even wastewater systems.

Microalgae can capture CO₂ from the atmosphere and convert it into biomass through photosynthesis. This biomass can be harvested and utilized in numerous applications, ranging from biofuel production to animal feed and even bioplastics. The versatility and rapid growth rates of microalgae make them attractive candidates for large-scale carbon sequestration efforts.

Need for carbon sequestration:

Traditional methods, such as afforestation and soil carbon storage, face limitations in terms of scalability and efficiency. In recent years,

microalgae have gained attention as a potential game-changer in the field of carbon capture. These microscopic organisms are not only capable of photosynthesizing more efficiently than terrestrial plants, but they also possess the ability to thrive in a variety of environments, including freshwater, marine, and even wastewater systems. Traditional methods, such as afforestation and soil carbon storage, face limitations in terms of scalability and efficiency. In recent years, microalgae have gained attention as a potential game-changer in the field of carbon capture. These microscopic organisms are not only capable of photosynthesizing more efficiently than terrestrial plants, but they also possess the ability to thrive in a variety of environments, including freshwater, marine, and even wastewater systems.

The carbon exchange between the atmosphere and oceans:

There are also significant exchanges of CO₂. These microscopic organisms are not only capable of photosynthesizing more efficiently than terrestrial plants, but they also possess the ability to thrive in a variety of environments, including freshwater, marine, and even wastewater systems. Traditional methods, such as afforestation and soil carbon storage, face limitations in terms of scalability and efficiency. In recent years, microalgae have gained attention as a potential game-changer in the field of carbon capture. These microscopic organisms are not only capable of photosynthesizing more efficiently than terrestrial plants, but they also possess the ability to thrive in a variety of environments, including freshwater, marine, and even wastewater systems.

Mechanisms of Carbon Sequestration by Microalgae:

Microalgae sequester carbon primarily through photosynthesis, a process that converts light energy into chemical energy, resulting in the fixation of CO₂ into organic compounds. The efficiency of this process in microalgae is due to several factors:

plastics and valuable biochemicals, reducing reliance on petroleum-based products.

✚ **Carbon Credits and Offsets:** The carbon captured by microalgae can be quantified and monetized through carbon credits, providing an economic incentive for companies to invest in microalgal

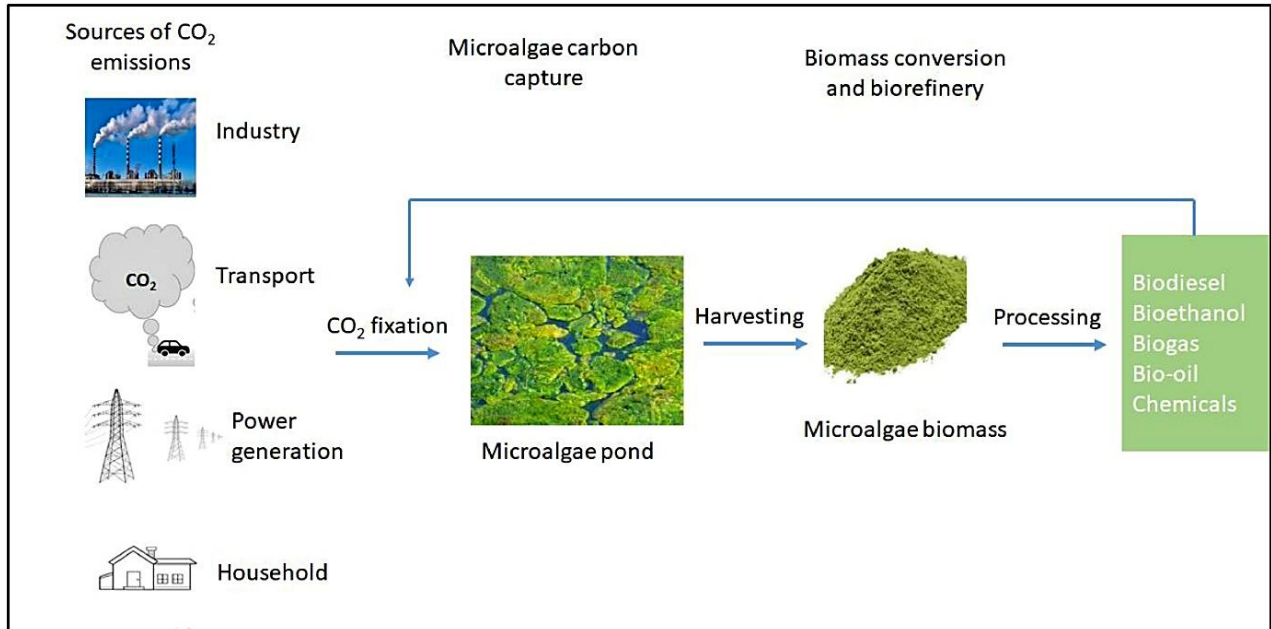


Figure 2: Microalgae cultivation, photosynthetic fixation of CO₂ into microalgae biomass, and biomass processing. (Image Credit: Onyeaka et al., 2021)

Applications of Microalgae in Carbon Sequestration

The biomass produced by microalgae can be harvested and utilized in various industries, providing a sustainable alternative to fossil fuel-based products:

- ✚ **Biofuel Production:** Microalgae-derived biofuels, such as biodiesel and bioethanol, offer a renewable and carbon-neutral energy source. Unlike traditional biofuels, microalgae do not compete with food crops for arable land. Microalgae biomass can be used for various applications, including animal feed, food supplements, and biodegradable plastics, enhancing its potential as a sustainable carbon capture solution.
- ✚ **Animal Feed and Aquaculture:** Algal biomass is rich in proteins, lipids, and essential nutrients, making it an excellent feedstock for livestock and aquaculture.
- ✚ **Bioplastics and Biochemicals:** Microalgae can be used to produce biodegradable

technologies.

Challenges and Future Prospects

Despite their potential, several challenges must be addressed to realize the widespread adoption of microalgae-based carbon sequestration:

1. **Cultivation Costs:** The cost of cultivating and harvesting microalgae at scale remains high. Advances in bioreactor design and process optimization are needed to improve cost-effectiveness.
2. **Scalability:** While microalgae can be cultivated in various environments, scaling up production to meaningful levels of carbon capture presents logistical and technical challenges.
3. **Genetic Engineering:** Enhancing the carbon sequestration capabilities of microalgae through genetic modification could significantly boost their efficiency. However, public acceptance and regulatory hurdles must be considered.
4. **Environmental Impact:** The potential ecological impacts of large-scale

microalgae cultivation, such as nutrient competition with natural ecosystems, must be carefully managed.

Conclusion

Microalgae hold immense promise as silent saviours in the battle against climate change through their ability to efficiently sequester carbon. Their versatility, rapid growth, and adaptability to diverse environments make them ideal candidates for carbon capture and utilization. While challenges remain, continued research and technological advancements could unlock the full potential of microalgae, transforming them into a cornerstone of sustainable carbon management strategies. As the world seeks to mitigate the impacts of climate change, microalgae offer a beacon of hope for a greener, more sustainable future.

Reference:

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