**DOI:** https://doi.org/10.54393/fbt.v4i01.97

FUTURISTIC BIOTECHNOLOGY
https://fbtjournal.com/index.php/fbt
ISSN (E): 2959-0981, (P): 2959-0973
Volume 4, Issue 1 (Jan-Mar 2024)

# Carboxysomes: Green Solutions for Sustainable Agriculture and Renewable Energy

**Fridoon Jawad Ahmad**[1]

[1]University of Health Sciences, Lahore, Pakistan
***drfridoon@yahoo.com***

ARTICLE INFO

***How to Cite:***

Jawad Ahmed, F. (2024). Carboxysomes: Green Solutions for Sustainable Agriculture and Renewable Energy. Futuristic Biotechnology, 4(01). https://doi.org/10.54393/fbt.v4i01.97

Carboxyomes are emerging as potential tools in the sustainable agriculture and biofuel production. They are proteinaceous organelles that are distributed in different species of photosynthetic bacteria and archaea and are significantly involved in carbon fixation. They enable the organisms to thrive in diverse environmental conditions and enhance the efficacy of photosynthesis. They have shown promising potential to address challenging regarding global food security, climate change and renewable energy.

These nanocompartments encapsulate Ribulose-1,5-bisphosphate carboxylase/oxygenase (RuBisCO), an enzyme that catalyzes the first step of the Calvin-Benson-Bassham cycle that is a key pathway in carbon fixation. These specialized structures concentrate $CO_2$ around RuBisCO ad shield it from the competing oxygen, thereby optimizing the efficiency of photosynthetic process and minimize wasteful photorespiration. The photosynthetic organisms having carboxysomes are therefore ideal candidates for sustainable agriculture as they are able to thrive in the harsh conditions such as low $CO_2$ concentrations, water scarcity and high temperatures.

They are recently being studied for enhancing the productivity and yield of crops. Efforts are being exerted to introduce carboxysome shell proteins and RuBisCO enzymes into crop genomes. Researchers are aiming to create plants with the ability to efficiently capture and utilize $CO_2$ for photosynthesis. These genetically modified crops can potentially increase crop yields, improve water and nutrient efficiency significantly. Moreover, these carboxysomal transgenes are also able to enhance the resilience of GM plants to different environmental stressors such as drought and heat, and ultimately contribute to global food security and sustainable agriculture.

In addition to their applications in agriculture, carboxysomes hold promise for biofuel production as well, as they are capable of carbon fixation. They have enabled researchers to engineer photosynthetic organisms to produce renewable fuels such as ethanol, biodiesel and hydrogen. Furthermore, nanobioreactors that are based on carboxysomes can contribute protectively against climate change as they have the potential to mitigate greenhouse gas emissions by capturing $CO_2$ from industrial emissions and converting it into valuable bioproducts.

This approach represents a promising avenue to address global challenges of food insecurity, climate crisis and rapidly declining non-renewable energy sources. If leveraged appropriately, these nanocompartments can significantly contribute in paving a way for more sustainable and resilient future.