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Methods of Increasing Biomass Productivity in Algae Cultures

Two challenges facing the world today include the ongoing pollution of the environment with carbon dioxide and the increasing consumption of the world's natural energy resources of fossil fuels. An elegant solution to these challenges would be to cultivate microorganisms such as algae that take and utilize carbon dioxide for their growth while producing alternative sources of energy as well as useful products, such as food, fertilizer, bioplastics, feedstocks and pharmaceuticals.

The usefulness of algae is limited, however, because of challenges in production and yield. Typically algae are grown in either open ponds or photobioreactors (PBRs). Open ponds are less expensive than PBRs, but they do not produce the best substrate yield and are impractical in desert environments or areas with limited space. Growth of algae in PBRs cannot reach the scale of culturing as an open pond. Further, growth is hindered by photosynthetic oxygen accumulation which leads to photoinhibition. Excess O2 has to be stripped from cultures with an out-gas station which limits the length of the PBR and subsequently increases the cost of the system.

Researchers at Arizona State University have developed a novel system for increasing biomass productivity in algae cultures by overcoming catabolic repression of photosynthesis. Cultivation apparatuses, substrates and cultivation conditions are optimized to increase biomass productivity in both open and closed culture systems. Further, certain algae species can be used to afford additional protections against contamination by virtue of the acidic pH values required for their growth. This system does not require excess O2 to be stripped from the cultures.

Overcoming catabolic repression of photosynthesis enables much higher biomass productivity and makes algae a much more attractive solution to our environmental problems.

Potential Applications

- Production of: biofuels, food, pigments, fertilizer, bioplastics, feedstocks, pharmaceuticals, etc.

- Waste treatment - urban food-waste diversion programs, wastewater from beverage and bottling companies or agriculture farms

- Production platform for products derived from synthetic biology and metabolic engineering

Benefits and Advantages

- 3-fold higher biomass productivity

- 2 times higher substrate yields relative to dark, aerobic fermentation systems

- Enables feedstock production using photobioreactors and photosynthetic oxygen

- Circumvents catabolic repression of photosynthesis

- Lower operational energy consumption and capital costs in establishing the system

- Reduced risk of heterotrophic contamination

- Avoids mass-transfer limitations associated with gas to liquid transfer

- Can be integrated into existing algal cultivation systems

- The culture does not need to be mixed to circulate gasses

For more information about the inventor(s) and their research, please see

Dr. Lammers' departmental webpage