Making Photosynthetic Biofuel Renewable: Recovering Phosphorus from Residual Biomass

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Introduction

Current energy consumption practices deplete fossil fuels, create greenhouse gases, and contribute to global warming. Biofuel from phototrophic microbes like algae and bacteria provides a viable substitute. Lipids and fatty acids are extracted from these microorganisms. Residual biomass includes nutrients, like phosphorus (P), which can be recycled to increase overall sustainability. This poster presents research which improves biofuel sustainability by refining phosphorus recycling.

Approach

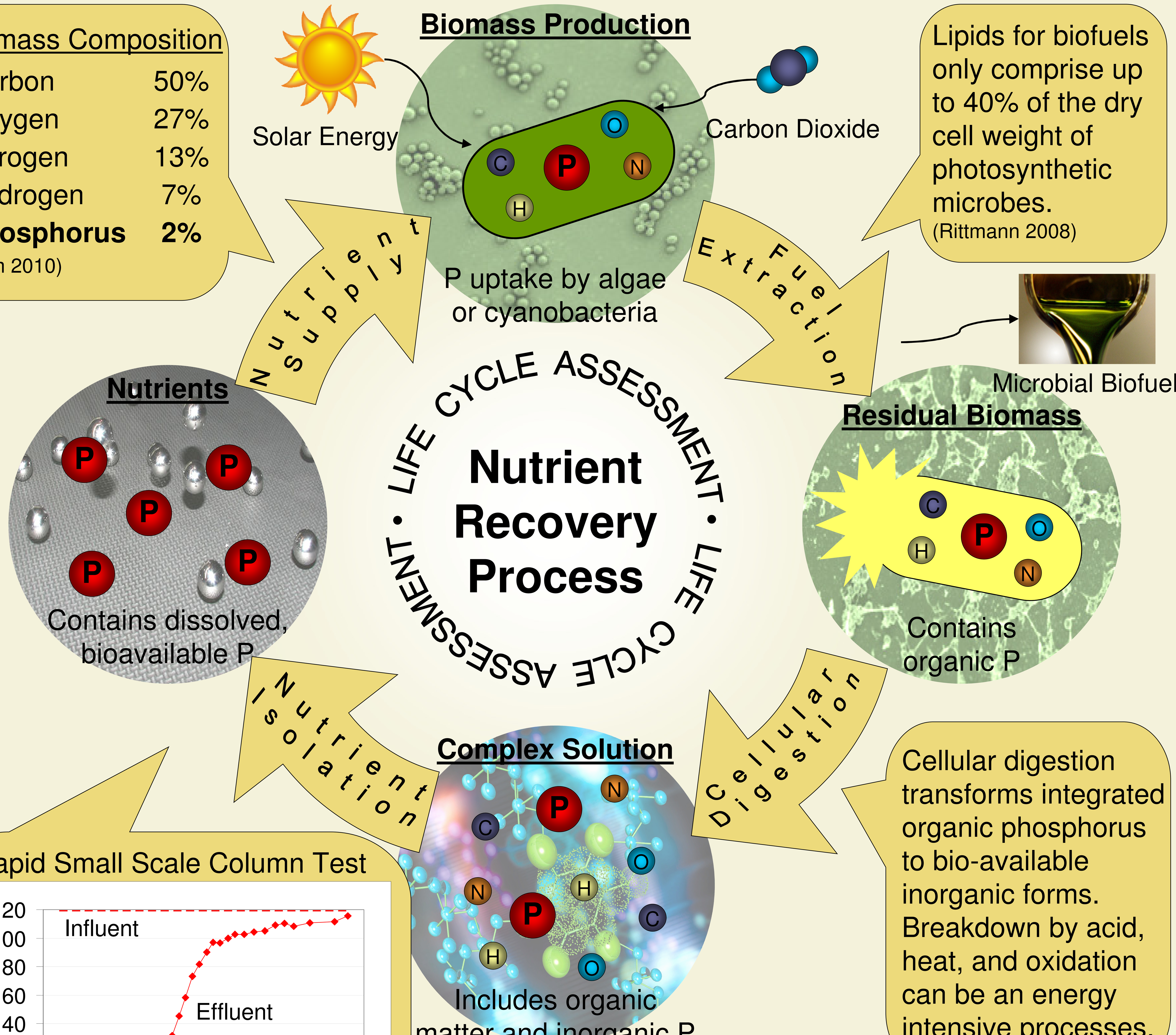
The research project is a two-phase effort. Phase one is a sustainability analysis of the biomass phosphorus recovery system. Life cycle assessment will identify the points of largest input, waste, energy requirement, or pollution. Phase two is refinement of the parts of the recovery process that are deemed crucial to improving sustainability. This will include laboratory testing of various methods. These phases are performed iteratively to ensure overall sustainability improvement.

Biomass Composition

Carbon	50%
Oxygen	27%
Nitrogen	13%
Hydrogen	7%
Phosphorus	**2%**

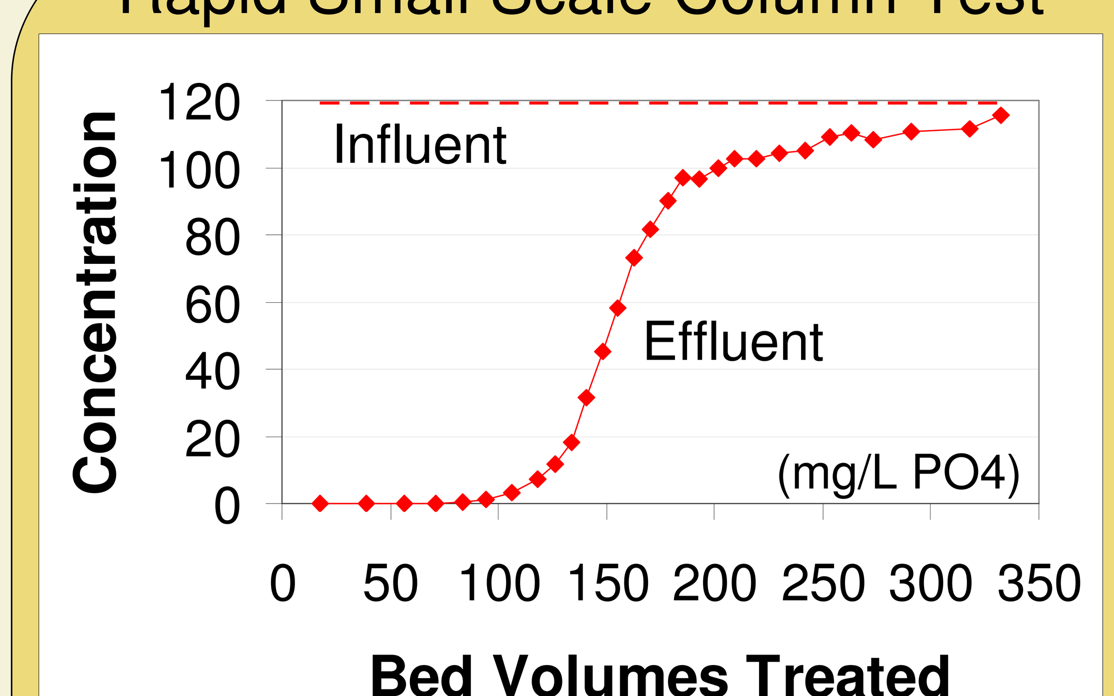
(Kim 2010)

Lipids for biofuels only comprise up to 40% of the dry cell weight of photosynthetic microbes. (Rittmann 2008)



Cellular digestion transforms integrated organic phosphorus to bio-available inorganic forms. Breakdown by acid, heat, and oxidation can be an energy intensive processes.

Rapid Small Scale Column Test



Phosphate Adsorption on Iron-Based Ion Exchange Resin

Initial Results

It is expected that the critical steps in the sustainability analysis will be digestion and isolation. Digestion methods include breakdown by acids, oxidation by hydrogen peroxide, and microwaving. Isolation methods include precipitation, adsorption, ion exchange, and biological uptake. Initial testing of an iron-based hybrid ion exchange resin showed high capacity for phosphate specific adsorption (see graph below left).

Broader Impact

Nutrient recovery has additional applications in wastewater treatment and fertilizer production. Global phosphorus reserves are depleting (Cordell 2009). Wastewater sludge may be a renewable source of nutrients for fertilizer if they can be adequately captured, increasing food availability across the globe. Improved recovery may also result in reduced agriculture runoff, reducing eutrophication of downstream water bodies and maintaining natural water resource quality.

References

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Rittmann, B.E., Opportunities for Renewable Bioenergy Using Microorganisms, Biotechnology and Bioengineering, V.100 N.2, June 2008.