

Self-deconstructing Algal Biomass as Feedstock for Transportation Fuels (#164662)

SAND2014-17958

PI: R. Davis (8634), FY12-14, \$435k

Purpose, Goals & Approach

Carbohydrates & proteins represent >50% of the potential algae fuels yield under high growth conditions. Goal: Convert **all** of the biochemical fractions to fuels

~30% of cost of algae biofuels related to liberating biofuel intermediates from biomass.

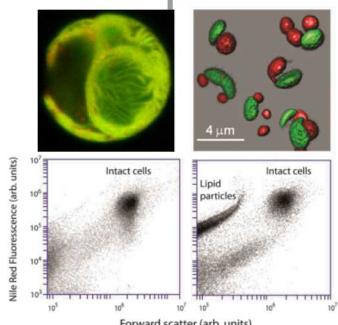
Expression of recombinant proteins in alga is a nascent technology – can this approach be used to facilitate low cost deconstruction?

Key R&D Accomplishments

Characterized compositional variability of two algae production strains under varying culture conditions & developed means for non-lethal liberation of lipid microparticles from *Dunaliella*

Demonstrated means for effective solubilization, hydrolysis, and conversion of algae biomass to liquid fuels

Completed transformation of *N. salina* for transgenic expression of 3 deconstruction enzymes at onset of lipid accumulation



Significance of Results

Optimized generally applicable low cost pretreatment strategy for solubilization and hydrolysis of algae biomass

Identified causes of recalcitrance in an algae production strain and genetically introduced enzymes for programmed autolysis

First demonstration of biochemical conversion of all of the major fractions of algae biomass to liquid fuels

Whole *Dunaliella* cell image, 3-D rendering of lipid bodies, and chloroplast, and release of lipid microparticles

What's Next

Results were employed to attract funding from DOE-EERE-BioEnergy Technologies Office for major nutrient recycling in algae production

Proposal submitted to DOE EERE Technologies Incubator program for tandem bio- and thermochemical conversion of natural algae assemblages (decision pending)

Proposal being developed for DEO-EERE-BETO for “Targeted Algae Biofuels and Bioproducts” FOA

Publications, Presentations, and IP Technology

List all publications resulting from this project, including those under review and in preparation.

- 1) Davis RW, Jones HDT, Collins AM, Ricken JB, Sinclair MB, Timlin JA, Singh, S. (2013) Label-free measurement of algal triacylglyceride production using fluorescence hyperspectral imaging. *Algal Research* DOI: 10.1016/j.algal.2013.11.010
- 2) Davis RW, Wu W, Singh S. (2014) Multispectral sorter for rapid, nondestructive optical bioprospecting for algae biofuels. *Proc. SPIE* DOI: 10.1117/12.2040538
- 3) Davis RW, Carvalho BJ, Jones HDT, Singh S. (2014) The role of photo-osmotic adaption in semi-continuous culture and lipid particle release from *Dunaliella viridis*. *J. Appl. Phycol.* DOI: 10.1007/s10811-014-0331-5
- 4) Davis RW, Wu W (2014) Co-extraction and transesterification of lipids and mixed alcohols produced from fermentation of algal biomass. *Biores. Tech.* (in prep)

List all external presentations resulting from this project. Identify invited conference presentations.

- 1) Davis RW, Jones HDT, Timlin JA, Singh S "Mechanism of nutrient-deprivation induced triacylglyceride accumulation in algae as revealed by fluorescence hyperspectral imaging" 58th Annual Meeting of the Biophysical Society, San Francisco, CA, Feb 15-19, 2014

List any intellectual property resulting from this project.

- 1) Davis RW "Tunable Dunaliella Bioplastic" SD#12823

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PM: B. Simmons (8630), FY12-14, \$435k

SMU Benefit & Timeframe

Impact and S&E Legacy

Efforts to Leverage R&D

What's Next