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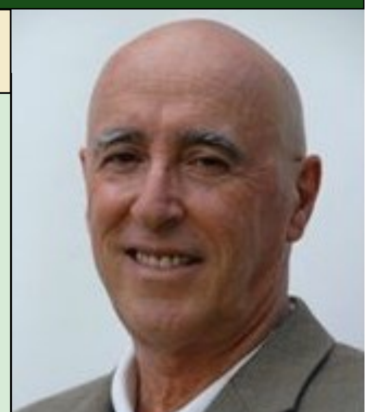
U.S. Department of Agriculture-NIFA

SunGrant INITIATIVE South Central Region

Project Title: **Building the Basis for the Improvement of Microalgae Oil Production Systems Efficiency Through the Quantification and Model Integration of Fundamental Biological and Physiological Processes**

DR. CARLOS FERNANDEZ



Project Goal

The goal of his project is to build the basis for the improvement of the efficiency of microalgae oil production systems through the quantification and integration by mechanistic modeling of fundamental processes governing the growth and lipid production of microalgae cultures. This project specifically aimed: 1) to quantify fundamental responses of selected microalgae strains during the phases of growth and oil biosynthesis, including carbon assimilation (photosynthesis), carbon losses (growth and maintenance respiration), biomass conversion efficiency, biomass production, and population dynamics, to various levels of primary environmental factors(i.e. water temperature, quantum flux interception , supply of CO_2), and 2) to integrate the fundamental biological and physiological responses to environmental factors quantified in the first objective into a mechanistic simulation tool for gaining understanding and assisting the analysis of microalgae-based oil production systems and improving their production efficiency.

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Funded: $160,000.00
Start Date: 11/01/2011
End Date: 10/31/2014

Project Outcomes

- The light attenuation coefficient obtained for N. salina growing in the bioreactors ranged from 0.0098 cm^{-1} &0.5385 cm^{-1}, depending on the culture biomass density, with lowest value corresponding to only saline water and higher value to a culture with a biomass density of 783 g m^{-3}. A linear regression with an intercept of 0.0326 cm^{-1} and slope of 0.0007 $m^3 g^{-1} cm^{-1}$ was obtained to numerically represent the effect of biomass concentration (in g m^{-3}) on the light attenuation coefficient (in cm^{-1}).
- Quantification of growth responses (cell population growth) of *N. salina* as affected by the combination of four temperature levels ranging from 15 to 27 ^{o}C and five levels of incident irradiance (on lit bioreactor side) of 893, 512, 358, 220, and 133µE $m^{-2} s^{-1}$ showed a significant interaction between these two environmental factors. A maximum cell population was obtained at average incident PPFD of 512µE $m^{-2} s^{-1}$ in combination with a culture temperature of 15^{O}C.
- A numerical mechanistic model was developed to simulate experimental growth data collected with the bioreactors. Outputs produced from this model demonstrated its capability for generating the basic trends of light dynamics, growth kinetics, nutrient uptake, and lipid production in the bioreactors. The model suggests that lipid production could be optimized to as much as 3.2724 g d^{-1} or 50.42 g $m^{-3} d^{-1}$.