

Secretome and Exometabolome Effects on Algal Media and Grazing "SEAMAG"

The minimum biomass selling price (MBSP) for algae is strongly influenced by the average annual biomass productivity. Continual grazing and culture crashes have a significant effect on the ability to achieve an annual average of 25 g/m²/d, the current target for the DOE to achieve cost-competitive biofuels from algae. In outdoor ponds at AzCATI, culture performance is consistently affected by fungi, bacteria, amoeba, and grazers which can have dramatic, negative effects on productivity, and thus MBSP. Two major components that have received limited attention on the impact of algal crop protection are the effects of the algal cultivation medium including abiotic and biotic factors. The effect of nitrogen and phosphorus on biomass productivity and composition is well known, but limited efforts have been completed to understand how media components can help or hinder algal predation and parasitism, in particular under actual outdoor cultivation conditions or under media/water recycling. Beyond the influence of the nutrients in the cultivation medium are the secretome and exometabolome, the organic molecules excreted during biological activity in the culture. In some cases, the molecules of concern that can trigger culture crashes are being produced by the algae themselves. In this project, we propose to use known infectious agents with established pest models to study and understand the effects of media composition and recycling on culture health. During cultivation the secretome and exometabolome will be analyzed to identify triggers that results in reduced productivity and culture crashes.

Our team consists of five partners: the Arizona Center for Algae Technology and Innovation (AzCATI) at Arizona State University (ASU), New Mexico State University (NMSU), Los Alamos National Laboratory (LANL), Lucendi, Inc., and Harmon Consulting, Inc. (HCI), bringing together a synergistic team with the necessary experience to address the challenge of algal crop protection. In this project, we propose to 1) use established algal-pest models to study and understand the effects of media composition on controlling predation rates, 2) track the secretome and exometabolome during growth in different types of media, and during media recycling, to identify triggers that result in reduced productivity and/or culture crashes, 3) identify media conditions and media/recycle water treatments that will help increase the mean time to failure and maintain productivity in algal cultures 4) develop the foundation for rapid and inexpensive lateral flow assay (i.e., dipstick tests) for any target compounds shown to predict periods of low productivity or culture crashes, and 5) advance a high throughput, low cost imaging flow cytometry platform to aid in tracking culture health.

If successful, we will improve the meant time to failure for algal cultures through 1) understanding abiotic factors that influence the virulence of algal pests, including pathogens and predators, through maintaining media compositions that reduce activity; 2) characterizing the secretome and exometabolome to identify molecules that are excreted by algae or its phycosphere that may trigger or allow an opportunistic predator to initiate significant culture grazing or parasitism; 3) applying cultivation media recycling to enhance economics and sustainability while ensuring consistent productivity. These three approaches will establish a method of cultivation that proactively reduces the negative impact of algae pests.