Title:

The Use of Natural Cues in Algae Downstream Processing and Biomanufacturing

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Abstract:

Microalgae are solar powered biomanufacturing platforms that are cultivated within photobioreactors and open raceway ponds. Raceway ponds are regarded as the most economically viable option for large scale, industrial cultivation systems for low to medium value products such as animal feed, pigments and industrial chemicals. To date, many challenges exist to increase the economics of these cultivation systems, including lowering energy inputs and using cleaner processes to avoid biomass contamination. This work focuses on exploiting naturally occurring chemical cues (infochemicals) produced by the algal-predator, *Daphnia*, to provide a clean harvesting methodology. These info-chemicals induce a defence mechanism of colony formation in microalgae to reduce their vulnerability against predation. The resulting colonies are too big for *Daphnia* to consume and induce algae sedimentation so that the algae are not accessible to the grazers. The present study demonstrates the role and mechanism of *Daphnia* infochemicals in colony formation and biological aggregate (floc) formation in the microalga of industrial interest *Scenedesmus spp.* and the importance of these processes in algae biomass harvesting. This was achieved by using a combination of meta-analyses, algal ecology and bio-physical analyses, pointing out the importance of these processes in algal biomanufacturing. The meta-analysis highlights grazer-specific levels of colony formation. Also, growth and composition of overall cultures and individual flocs across various stages was evaluated to determine whether these predation cues affect microalgae growth and whether the flocculation mechanism is due to an altered cell division process (colony formation) or due to adhesion of dispersed cells via a EPS (extra polymeric substances) matrix. Flocculation efficiency was examined at the different growth stages to provide quantitative information for optimum harvesting. Results show that flocculation occurs at earlier algal growth stages and due not to morphology variations but rather to the formation of a slimy layer surrounding the cells, composed by sugars, proteins and lipids. Finally, the proteomic response of *Scenedesmus* to *Daphnia* infochemicals was studied to reveal major metabolic pathways altered by exposure to the cues. The outcomes demonstrate the advantages of using natural infochemicals over traditional coagulants, including lowering costs and a more sustainable and environmentally friendly harvesting process with reduced contamination of the growth media and feedstock.