The production of cyanobacterial biofilms and phycocyanin from Rotating Algal Biofilm Reactors utilizing undiluted produced water from oil and natural gas extraction as a culture medium was investigated in this study. Produced water is the largest waste stream generated by the oil and natural gas industries and represents a large volume of non-potable water that may be available for algae culture with minimal impact on freshwater resources. Phycocyanin production was examined from the cyanobacteria dominated biofilms cultured in produced water and phycocyanin yield enhancements were investigated with a light limiting approach. A novel Oscillatoriales strain was isolated from the Logan City Wastewater Treatment Facility in Logan, Utah and used in conjunction with the Rotating Algal Biofilm Reactor platform for the duration of this study.

Ash Free Dry Weight (AFDW) areal biomass productivities of up to 4.8±0.7 g/m²-day were observed using laboratory scale 1 L bioreactor units and 220 µmol photons/m²-s PAR. Areal phycocyanin productivity was shown to be 84.6±9.3 mg/m²-day with an associated crude phycocyanin extract purity of 0.23±0.03. A lower light intensity of 40 µmol photons/m²-s PAR resulted in an average 87.6% increase in phycocyanin yield and a 230% increase in crude phycocyanin extract purity. A lower AFDW biomass productivity of 2.7±0.4 g/m²-day resulted in areal phycocyanin productivities that were statistically similar between the two light treatments.

An evaluation of growth substrata was conducted with cotton rope and conveyer cloth materials found to be the most durable and having the highest yields of harvestable biomass. The cotton rope and cotton conveyor cloth materials were evaluated on a Rotating Algal Biofilm Reactor operating in an outdoor 2000 L produced water pond. The cotton rope yielded a near 140% increase in AFDW biomass vs. the cotton cloth although the compositions varied greatly. The cotton cloth biomass showed a more robust phototrophic biofilm with higher phycocyanin yields and lower Autotrophic Indices (47.0 vs. 3.4 mg/m² and 127 vs. 507, respectively for cotton cloth vs. cotton rope). These results show promise for the utilization of produced water to culture cyanobacteria dominated biofilms with modifiable biomass characteristics as a source of high value phycocyanin pigments.