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Proliferation and Oxygen Production of Arthrospira platensis in Varying Light Intensities

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Proliferation and Oxygen Production of *Arthrospira platensis* in Varying Light Intensities

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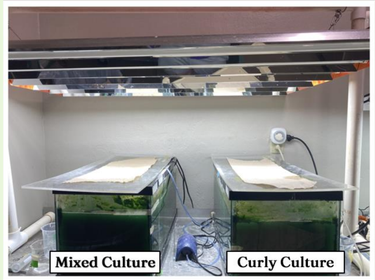
Abstract

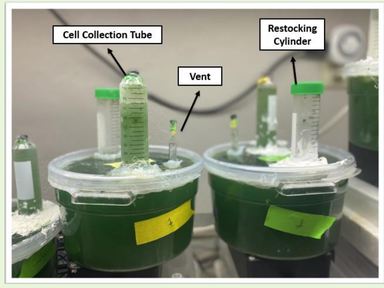
As space travel becomes more advanced, adequate nourishment and oxygen resources are crucial issues for scientists concerning long-term travel. *Arthrospira platensis*, also known as spirulina, is a protein rich cyanobacteria that could potentially provide a solution to these issues with minimal energy consumption. Spirulina is known to be used for protein supplementation with various health benefits and pharmacological applications. In addition, spirulina cultures produce high amounts of oxygen through photosynthesis using carbon dioxide. Proliferation and oxygen production are primarily dependent on the spirulina cell structure (straight or coiled). A mixed culture (containing straight and spiral Spirulina cells) and a spiral Spirulina culture were studied under 40 µM, 60 µM, and 80 µM light intensities in order to determine the behavior of cell reproduction and its effects on oxygen production. Six 2.5 L containers with Spirulina were placed under a light and elevated to reach the desired light intensities. Cell reproduction and oxygen production were monitored in 24-hour intervals for a total of 168 hours.

Materials

- ❖ Two stock cultures of *Arthrospira platensis* were utilized for experimentation: [Fig. 1]
- Mixed culture containing a 70:30 straight to curly (spiral) forms of spirulina
- Curly culture containing spiral spirulina
- ❖ Zarrouk's media
- ❖ Six experimental containers [Fig. 2]
- 2.5 L containers with two 50 mL test tubes for collection and restocking and one ventilation tube
- ❖ Hemocytometer
- ❖ Boxes
- ❖ Stir Bars and Stir Plates
- ❖ Timers



[Fig.1] Stock Cultures

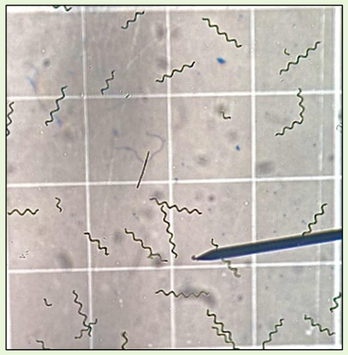


[Fig. 2] Experimental Containers

Materials and Methods

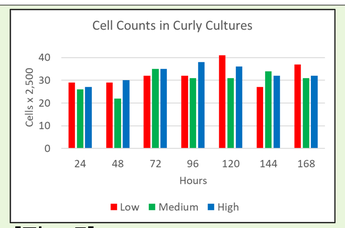
Two stock cultures of *Arthrospira platensis* were utilized for experimentation: a mixed culture (containing straight and spiral forms of spirulina) and a culture containing spiral (curly) spirulina. Six 2.5 L containers were placed under a white light for 7 days (168 hours). Each container contained 1 L of spirulina cells and was filled to the top with 10% Zarrouk's media. Zarrouk's media served as a source of bicarbonate for the spirulina to use in photosynthesis to yield oxygen. One container from each culture was placed under 40 µM, 60 µM, and 80 µM light intensities. This was done by placing the containers on boxes to move them closer to the light [Fig. 3]. Cells were exposed to 14 hours of light and 10 hours of darkness each day. Oxygen production was measured through tubes protruding from the top of each container and recorded every 24 hours. Cell counts were performed on samples from each container using a hemocytometer every 24 hours [Fig. 4]. After samples were extracted from the containers, 4 mL of Zarrouk's media were administered into each container. Then, the container was filled to the top with deionized water. There were three replicates of each culture at each light intensity. Data from the cell counts and oxygen production were analyzed using R.

[Fig. 3] Cultures under 40 µM, 60 µM, and 80 µM light intensities

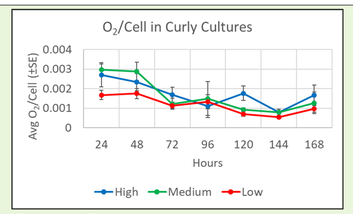


[Fig. 4] Cell counts using a hemocytometer

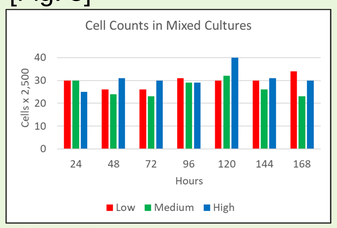
Results and Discussion



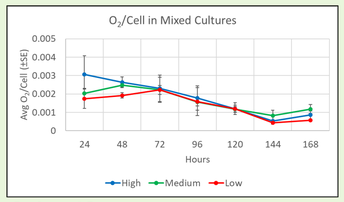
[Fig. 5]



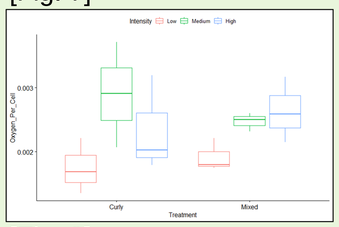
[Fig. 6]



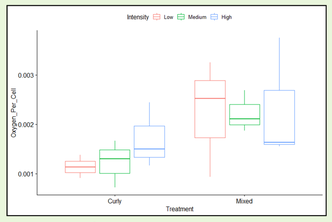
[Fig. 7]



[Fig. 8]



[Fig. 9]



[Fig. 10]

In the curly and mixed cultures, cell counts were moderately consistent over the 7 day period [Fig. 5] [Fig. 7]. Oxygen produced per cell was highest in the first 48 hours in the curly cultures [Fig. 6]. In the mixed cultures, oxygen produced per cell was highest within the first 72 hours before decreasing a considerable amount [Fig. 8]. To gain further data on oxygen production between 48-72 hours, data was tested with a 2-way ANOVA test followed by a post-hoc Tukey test using R at 48 and 72 hours in both cultures. At 48 hours, 60 µM and 80 µM light intensities produced significantly more oxygen per cell in both cultures (P-Value: 0.046) [Fig. 9]. At 72 hours, only mixed cultures produced significantly more oxygen per cell (P-Value: 0.034) [Fig. 10]. This data supports the idea that Arthrospira platensis could be recultured every 48-72 hours to harvest the maximum amount of oxygen. If reculturing were to be accomplished by human consumption, it would provide the optimum amount of oxygen to a spacecraft while also providing astronauts with an ample source of protein, vitamins, and minerals.

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