Examining the impact of light intensities on algae growth with Space biology implications

Summary

Human exploration of Mars is one of the key scientific and technological undertakings of our time, providing critical information enabling the discovery and settlement of another world while inciting the development of technologies on Earth. Current research is underway to enable crewed missions to Mars for long term space exploration. This has underscored the critical need for advanced bio-regenerative life support systems (BLSS) which is a complex mix of biological and engineering systems. Algae have long been proposed for space life support systems to recycle CO_2 and provide food either directly or indirectly to astronauts. Light intensities and wavelengths are vital parameters to consider while growing microalgae. The amount of sunlight on Mars is approximately half that of Earth and it can also be obscured for weeks at a time by dust storms. Varying light intensities and long periods of darkness that might arise on long-term space missions and on Mars are likely to inhibit microalgae growth either because of the shortage in light energy or due the photo-inhibition caused by excessive irradiance. Many species of microalgae are photosynthetically efficient under the limiting light and low volume conditions necessary in space production. A few past studies exposed or grew algal species in space conditions. However, according to a recent review by Niederwieser et at. (2018), from over 50 algal spaceflight experiments conducted thus far, data is still quite limited and did not consider a combined effect of the biocidal effects of atmospheric conditions prevalent on Mars.

Here we explore the potential of extremophilic algae such as snow algae *Chloromonas brevispina,* halophilic *Dunaliella salina,* that are naturally exposed to multiple extreme conditions of temperatures, light intensities, salinity, UV exposure and low pressure, for space biotechnology applications. We have previously grown microalgae under challenging conditions of low pressure and nutrients and our preliminary results revealed these candidate algae species growing at pressure as low as 80 mbar also using Mars regolith simulants as nutrients (Harrold et al., 2018; Cycil et al., 2021). Here we expand upon this previous work to test the growth of the candidate microalgae under varying light intensities and different durations of dark period to determine the survivability and tolerance of these species under varied light conditions. The proposed work will be helpful towards designing a sustainable BLSS for Mars.