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Microgravity Experiments from Sub-Orbital to Orbital Platforms (3)

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DEVELOPMENT AND TESTING OF A MICROGRAVITY AEROPONICS ROOT CHAMBER TRAY

Abstract

As space technology advances, the duration of crewed missions will also increase. With the aim of sending crewed missions to Mars in the coming future, the provision of food presents itself as a major challenge. Crew dietary needs can be met using packaged foods and supplements, however fresh crops grown in-situ can enhance this diet and allow for a reduction in mission (re-)supply mass. Furthermore, plants can facilitate the recycling of carbon dioxide/oxygen, and have also been shown to bring forth positive psychological effects on astronauts. As such, experiments such as Veggie, Advanced Plant Habitat, and others are being carried out to test plant growth in microgravity. However, they all have used some form of growth media or soil, some of which have revealed issues such as non-uniform water supply to the root-zone, resulting in lower crop yields or crop failure.

By studying these experiments, and integrating knowledge from previous experiments, a microgravity aeroponics root chamber was designed and developed. Such a system would allow the required (re-)supply volume and mass to be reduced by eliminating the need for growth media, thereby reducing operational costs. By taking inspiration from the "Space Coffee cup" and studying the mathematics behind capillary flow experiments in microgravity, the tray design allows for a controlled supply and removal of the nutrient solution from the plant root zone. The design incorporates a high velocity, interval mist spray using a multi-mister configuration, with intermediate air jet bursts to dislodge excess "clumped" water to prevent root asphyxiation. Drop-tower microgravity experiments have shown promising results with simulated root zones of plants at different stages of their life cycle.