NUTRITION OF ANTARCTIC-GROWN CROPS TO SUPPLEMENT THE CREW DIET, WITH APPLICATIONS FOR SPACEFLIGHT

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Access to fresh produce during longer-duration spaceflight missions is being explored as a countermeasure for human biobehavioral health and performance, including how fresh fruits and vegetables can supplement the crew diet with nutrients that are predicted to become deficient throughout the missions. Studies in Veggie and the Advanced Plant Habitat plant chambers on the International Space Station (ISS) have tested pick-and-eat crops in spaceflight. However, the limited plant cultivation volume of these chambers has restricted sample sizes and biomass available for nutrition assessment. Further, as plant production systems intended for planetary surfaces will likely differ in design from those used in microgravity, it is important to identify system- and environment-specific effects. To gain a better understanding of the nutrient composition of pick-and-eat crops, leafy greens and fruiting plants were grown in the EDEN ISS plant cultivation facility near Germany's Neumayer Station III (NM-III) in Antarctica from March 2021 to January 2022. Target crops for nutrition sampling aligned with cultivars grown in spaceflight, including 'Outredgeous' red romaine lettuce, mizuna mustard, 'Red Robin' dwarf cherry tomato, and NuMex 'Española Improved' chile pepper. Plants subsamples were taken at harvest; in the event of multiple harvests from the same plants, subsamples were taken at both the first and final harvests to assess how factors like plant age and the number of days of facility operation may impact nutrient composition. Subsamples were first weighed for fresh mass, dried in a dedicated oven at 70°C for 96 h, weighed again, and stored in air-tight containers inside NM-III. Nutrient solution samples were also collected throughout the season and stored in a dedicated -40°C freezer inside NM-III. At the beginning of 2022, the samples were shipped in temperature-stable containers to NASA's Kennedy Space Center (KSC), where they were analyzed with ion chromatography and inductively coupled plasma - optical emission spectrometry (ICP-OES). Crop samples were analyzed for 14 elements, phenolic content, and antioxidant content (Oxygen Radical Absorbance Capacity, ORAC). Nutrient solution samples were analyzed for crop micro- and macronutrients. Leafy greens were higher than fruiting crops in key elements like calcium, magnesium, and zinc. Further, crop nutrition was stable over time, an indicator that a nutrient delivery system with exchangeable and amendable nutrient solution should be included in future designs. This study aimed to improve the space crop selection process and inform about how pick-and-eat crops should be cultivated during future spaceflight missions. This project was a collaboration between the German Aerospace Center (DLR) and NASA, with funding for sample analyses provided by the 2023 NASA Human Research Program Grant Augmentation Award, and additional support from the University of Bremen.