

Veggie: Space Vegetables for the International Space Station and Beyond

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The Veggie vegetable production system was launched to the International Space Station (ISS) in 2014. Veggie was designed by ORBITEC to be a compact, low mass, low power vegetable production system for astronaut crews. Veggie consists of a light cap containing red, blue, and green LEDs, an extensible transparent bellows, and a baseplate with a root mat reservoir. Seeds are planted in plant pillows, small growing bags that interface with the reservoir. The Veggie technology validation test, VEG-01, was initiated with the first test crop of 'Outredgeous' red romaine lettuce. Prior to flight, lettuce seeds were sanitized and planted in a substrate of arcillite (baked ceramic) mixed with controlled release fertilizer. Upon initiation, astronauts open the packaged plant pillows, install them in the Veggie hardware, and prime the system with water. Operations include plant thinning, watering, and photography. Plants were grown on the ISS for 33 days, harvested, and returned frozen to Earth for analysis. Ground controls were conducted at Kennedy Space Center in controlled environment chambers reproducing ISS conditions of temperature, relative humidity, and CO₂. Returned plant samples were analyzed for microbial food safety and chemistry including elements, antioxidants, anthocyanins and phenolics. In addition the entire plant microbiome was sequenced, and returned plant pillows were analyzed via x-ray tomography. Food safety analyses allowed us to gain approvals for future consumption of lettuce by the flight surgeons and the payload safety office.

A second crop of lettuce was grown in 2015, and the crew consumed half the produce, with the remainder frozen for later analysis. This growth test was followed by testing of a new crop in Veggie, zinnias. Zinnias were grown to test a longer duration flowering crop in preparation for tests of tomatoes and other fruiting crops in the future. Zinnias were harvested in February. Samples from the second harvest of lettuce and the zinnia harvest are frozen on the ISS and will return with the next cargo return flight. Some challenges occurred in all tests, especially in the area of watering, with plants receiving insufficient or excess water leading to stressed growth. Zinnia plants were also challenged with fungal growth. Initial tests with Veggie have given us great insight into future crop production scenarios as we work to develop regular supplemental salad crop production on ISS and larger food production systems for our journey to Mars. Funding for this research comes from NASA's Space Biology Program.