PREPARATION FOR PICK-AND-EAT FOOD PRODUCTION ON THE INTERNATIONAL SPACE STATION: FLIGHT DEFINITION FOR THE VEG-04 AND VEG-05 MISSIONS

G.D. Massa[1], R.M. Wheeler[1], M.W. Romeyn[1], M.E. Hummerick[2], L.E. Spencer[2], R.C. Morrow[3], C.A. Mitchell[4], S. Burgner[4], A.M. Whitmire[5], M.H. Young[6], G.L. Douglas[6].
[1] NASA, Kennedy Space Center, FL, USA, [2] Vencore-ESC, Kennedy Space Center, FL, USA, [3]ORBITEC, Madison, WI, [4]Department of Horticulture and Landscape Architecture, Purdue University, West Lafayette, IN
[5]Wyle Life Science, Johnson Space Center, TX, [6]NASA, Johnson Space Center, TX, USA.

ABSTRACT

Growth of fresh, nutritious, palatable produce for crew consumption during spaceflight may provide health-promoting, bioavailable nutrients and enhance the dietary experience as we move toward longer-duration missions. Tending plants also may serve as a countermeasure for crew psychological stresses associated with long duration spaceflight. However, requirements to support consistent growth of a variety of high quality, nutritious crops under spaceflight environmental conditions is unknown. This study is exploring the potential to grow plants for food production on the International Space Station (ISS) using the Veggie vegetable production system. Ground testing is underway to compare the impacts of several fertilizer and lighting treatments on growth, quality, and nutritional composition of the leafy green crop mizuna, and the dwarf tomato crop 'Red Robin' when subjected to Veggie ISS environmental conditions. Early testing focused on the leafy crop 'Tokyo Bekana' Chinese cabbage, but ground tests indicated that this plant suffered from stress responses when grown under LEDs and the chronically elevated CO_2 levels found on the ISS. Mizuna, a related leafy variety that grows well in the presence of high CO_2, and has excellent organoleptic characteristics, was selected as an alternate crop. Tomato crops have been grown using two fertilizer formulations and two pollination techniques, and growth tests using different red:blue lighting environments are underway. Chemical analysis is also being conducted and these data, when coupled with the growth results, will be used to down-select to the two best lighting treatments and best fertilizer treatment for future testing of each crop on the ISS. Additionally, seed-source testing has become important, with mizuna seeds from two different vendors growing very differently. A seed source has been selected, and seed-surface-sanitizing methods have been confirmed for mizuna, but these remain under development for tomato. A crop-handling protocol is also being evaluated to support food safety. All harvests reserve a subset of samples for microbial analysis to determine baseline microbial levels and help establish critical control points for food safety. Testing was initially conducted in hardware analogs of the standard Veggie plant pillows. However, a new Veggie watering system, the Passive Orbital Nutrient Delivery System or PONDS, has been designed and is being prepared for future flight experiments. With the selection of this growth system, ground tests have shifted to analog PONDS systems. Crop tests on ISS, designated VEG-04 for mizuna and VEG-05 for tomato, are planned in 2018 to evaluate any additional impacts of spaceflight on the light and fertilizer conditions down-selected from ground tests. A set of Veggie-specific questions has been developed to characterize the psychological impacts of plant growth and plant-care activities during spaceflight. Organoleptic questionnaires have been developed to assess produce attributes in microgravity taste sessions. These tests for plants growing in the Veggie hardware on ISS will help to mitigate the risk of an inadequate food supply for long duration missions by developing methods and determining hardware requirements to integrate fresh vegetables as a dietary supplement. This research was co-funded by the Human Research Program and Space Biology (MTL#1075) in the ILSRA 2015 NRA call.