

# Microbiological Quality And Food Safety Of Plants Grown On ISS Project

Center Independent Research & Developments: KSC IRAD Program  
Mission Support Directorate ( MSD )

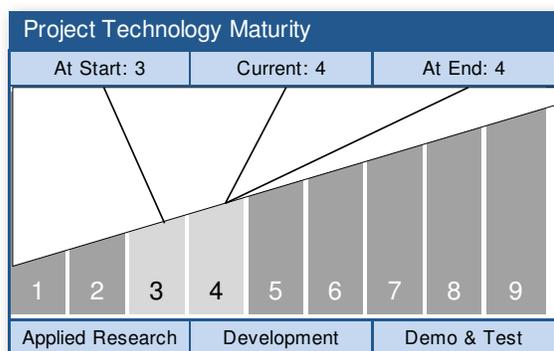
National Aeronautics and  
Space Administration



## ABSTRACT

The goal of this project is to select and advance methods to enable real-time sampling, microbiological analysis, and sanitation of crops grown on the International Space Station (ISS). These methods would validate the microbiological quality of crops grown for consumption to ensure safe and palatable fresh foods. This would be achieved through the development / advancement of microbiological sample collection, rapid pathogen detection and effective sanitation methods that are compatible with a microgravity ...**Read more on the last page.**

*Radish and Lettuce Microbiological Quality and Food Safety*



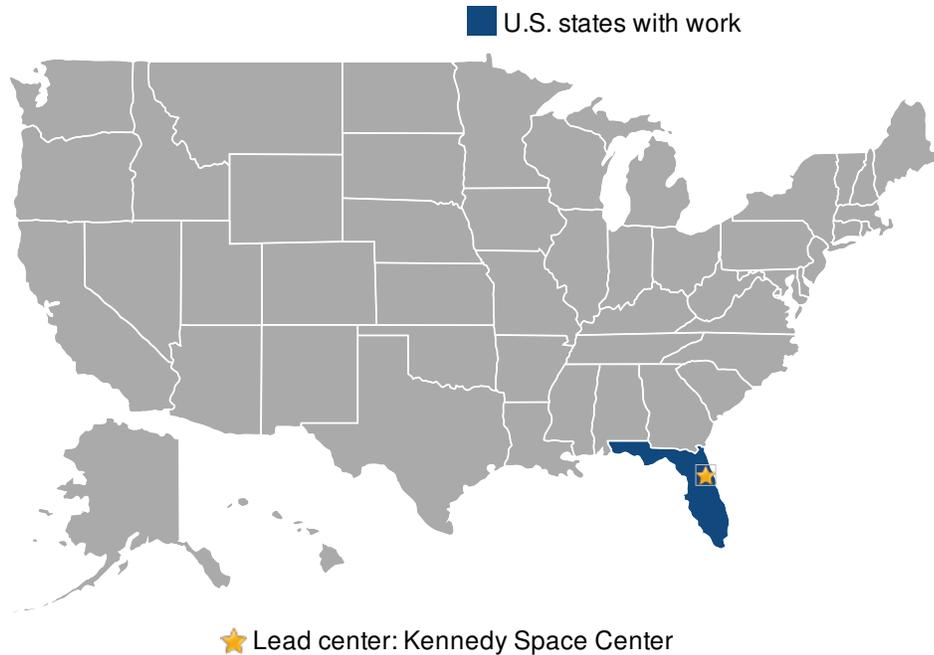
Technology Area: Human Exploration Destination Systems TA07 (Primary)  
Human Health, Life Support & Habitation Systems TA06 (Secondary)

## ANTICIPATED BENEFITS

### To NASA funded missions:

Methods specifically designed for quality assurance of fresh produce grown and consumed in space have yet to be defined. Currently, NASA astronauts cannot consume fresh foods grown in space. The need exists, as vegetable production units are being deployed on the ISS. The VEGGIE plant growth unit, developed by Orbitec, was recently launched to the ISS and will be growing edible salad crops, and the Advanced Plant Habitat could also be used for future food production ...

Read more on the last page.



## DETAILED DESCRIPTION

A challenge for growing fresh foods (vegetables) in space is demonstrating that they are safe for consumption according to NASA microbiological standards set for food. The goal of this project is to select and advance methods to enable real-time sampling, microbiological analysis, and sanitation of crops grown on the ISS. These methods would validate the microbiological quality of crops grown for consumption to ensure safe and palatable fresh foods. This will be achieved through the development / advancement of microbiological sample collection, rapid pathogen detection, and effective sanitation methods that are compatible with a microgravity environment.

The work aligns with current plans for deployment of a vegetable production unit on ISS (Veggie) and the procurement and evaluation of platforms (RAZOR) at Kennedy Space Center for rapid microbial monitoring on ...

### MANAGEMENT

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**Principal Investigator:**  
Raymond Wheeler

**Co-Investigators:**  
Gioia Massa  
Anna Maria Ruby

## DETAILED DESCRIPTION (CONT'D)

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ISS.

A 3-step approach is being used to evaluate and modify methods for analyzing fresh produce (fresh vegetables / fruits) that would be compatible with a microgravity environment. Candidate food crops are being grown in a controlled environment chamber for the following tests:

- Assessment of sampling procedures for surfaces of edible plant material to gather meaningful microbiological data. The three sample methods are surface swabbing, the use of adhesive tape to collect surface microbes and a blender method to remove microbes from plant tissue. The blender method is the conventional method for food sample processing. The other two methods have been tested as portable real-time methods to collect samples from the surfaces of meat as well as produce including tomato fruit and leafy greens
- Analysis of samples using polymerase chain reaction (PCR), ATP analysis, and culture based methods for enumeration as well as identification of target organisms with an emphasis on approaches that yield rapid results. The methods employed are all commercially available technologies. Our goal is to reduce detection time with the constraints of methodology that could practically be used on the ISS for sample analysis.
- Comparison of sanitizing and disinfection procedures for the vegetables and plant growth unit surfaces, including methods developed and tested in the AES Habitat Demonstration Unit (HDU). The focus is on the development of a sanitizing wipe that can be used on plant growth systems such as Veggie as well as edible plant surfaces to reduce the microbial load. The sanitizer being used is a citric acid based food grade sanitizer (Pro-San®). This sanitizer has been tested previously and has been shown to be effective in the sanitization of edible vegetables.

### Progress

A series of experiments has been completed using 3 different sampling procedures, swabbing, adhesive tape collection and sample blending for the recovery of bacteria from the surface of radish, tomato and lettuce. Data collected and analyzed to date show no significant difference using culture based detection methods between the adhesive tape and bag blender sample methods in the recovery of *Salmonella enterica* Typhimurium, a human associated food borne pathogen inoculated onto the surface of lettuce, tomato, and radish. The swab method recovery was significantly lower than the other two methods in the case of lettuce and radish. With the samples collected by these different sampling procedures we are comparing detection and quantification methods, specifically real-time quantitative polymerase chain reaction (q-PCR) using two platforms, the LightCycler® (Roche Diagnostics) and a rapid portable system, the RAZOR (Biofire, Salt Lake City, UT) with conventional culture based methods. For these tests we used *S. enterica* Typhimurium and *Escherichia coli* K12 inoculated onto the surface of red leaf lettuce and radish. We were able to detect *S. enterica* from 5/5 samples recovered from radish. This rapid method would eliminate the need for plating onto media or DNA ...



## DETAILED DESCRIPTION (CONT'D)

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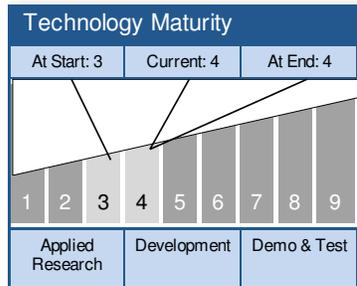
extraction followed by RT-qPCR shortening detection and enumeration time from 12-48 hrs to approximately 3 hours.

Two concentrations of sanitizer-saturated wipes were tested to lower the microbial counts on radish, tomato and lettuce and plastic surfaces similar to the materials that comprise the Veggie plant growth system. The sanitizer was effective in lowering the bacterial count by 90- 99.9% on vegetable surfaces and up to 99.99% on plastic surfaces.



## TECHNOLOGY DETAILS

### Sampling and Sanitizing Capability for Space-Grown Foods



### TECHNOLOGY DESCRIPTION

The goal of this technology is to select and advance methods to enable real-time sampling, microbiological analysis, and sanitation of crops grown on the ISS. These methods would validate the microbiological quality of crops grown for consumption to ensure safe and palatable fresh foods. This would be achieved through the development / advancement of microbiological sample collection, rapid pathogen detection and effective sanitation methods that are compatible with a microgravity environment.

This technology is categorized as a hardware component or part for ground scientific research or analysis

- Technology Area
  - TA07 Human Exploration Destination Systems (Primary)
  - TA06 Human Health, Life Support & Habitation Systems (Secondary)

### CAPABILITIES PROVIDED

This technology will provide an initial capability for sampling and sanitizing fresh vegetables grown in space settings like ISS, which in turn could allow the direct consumption of space grown foods by the crew.

This technology could be applied on ISS or future space exploration missions where human crews might grow their own foods in situ.

Performance Metrics		
Metric	Unit	Quantity
Drop the microbial counts on food surface by 10 <sup>3</sup> CFU	Colony Forming Units-CFU	10 <sup>3</sup>

## IMAGE GALLERY

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Food Safety Testing at KSC



Radish and Lettuce Microbiological Quality and Food Safety

## ABSTRACT (CONTINUED FROM PAGE 1)

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environment.



## ANTICIPATED BENEFITS

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### **To NASA funded missions: (CONT'D)**

work.

### **To NASA unfunded & planned missions:**

These same capabilities developed for food production on the ISS could be translated to future human exploration efforts, such as NEO, Mars Transit, Lunar Surface, and Mars Surface missions.

### **To other government agencies:**

There are potential benefits for USDA related efforts in controlled environment agriculture and even DOD efforts that might consider deploying portable food production units in field settings.

### **To the commercial space industry:**

Aerospace companies that have interests or aspirations for developing orbiting human habitats or transit vehicles could benefit from this research and technology development.

### **To the nation:**

This work contributes to national interests in food safety.

