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**Title:** Microgravity Demonstration of a Novel In-Space Food Production System

## Summary

The overarching goal of this project is to demonstrate the use of a novel bioreactor technology for growing high-protein food on the International Space Station (ISS). The bioreactor technology has been demonstrated on Earth to efficiently convert mission-relevant feedstocks, like plant, human and food waste, into thick (> 6 mm) high-protein, edible, fungal biomats. A flight experiment is now needed to demonstrate bioreactor efficacy under low-Earth orbit conditions, and thus evaluate the effects of both micro-gravity and space radiation on bioreactor performance. The bioreactor is relatively simple, does not require energy during fermentation (other than possibly temperature control), requires little water, and rapidly grows dense, easily harvested, consolidated biomats for food with little to no remaining waste. The technology capitalizes on the unique growth characteristics of an extremophilic, filamentous fungus isolated from a geothermal spring in Yellowstone National Park, named strain MK7. Strain MK7 is an FDA Generally Recognized as Safe (GRAS) food ingredient and is now available to the US public as a breakfast sausage, with the product line expected to significantly expand by the end of the year.

The bioreactor technology was developed by Sustainable Bioproducts LLC (SBP), Montana State University (MSU) and BioServe Space Technologies during a NASA supported collaborative research project titled A Robust Biofilm-Bioma Reactor for Conversion of Mission Relevant Feedstocks to Products (NASA STTR Phase I and II Award # 80NSSC20C0031). The Aim of the ongoing NASA STTR-supported research is the advancement and scale-up of the proprietary bioreactor technology so that it can be used in space for food production. The bioreactor is currently at Technology Readiness Level (TRL) 5, with the prototype bioreactor successfully demonstrated on Earth.

The flight study will require no crew involvement other than installation and removal of a Plate Habitat (PHAB) into an ISS incubator. PHABs are robust, flight-proven containers used for performing spaceflight biology experiments with more than 100 individual PHABs successfully flown. The PHAB technology will serve as a safe secondary containment box for housing the MK7 fungal bioreactors. The final hardware validation and safety evaluation steps are anticipated to be completed, with the system ready to fly, in less than one year. The mission approach is to preload the bioreactor with inoculum and nutrient medium, seal the bioreactor within a PHAB, freeze the PHAB at -20 °C to place culture in stasis, and handover the payload to NASA for transport to the ISS in a frozen state. The PHAB can be stored frozen onboard the ISS for up to one month before initiation of the experiment to allow for maximum operations flexibility. To initiate the experiment, the PHAB will simply be placed in a Space Automated Bioproduct Lab (SABL) incubator and incubated at + 27 °C for five days. After incubation and growth, the PHAB will be refrozen and stored in a freezer until the eventual return to Earth in a frozen stable state. Retrieved bioma samples will be evaluated by MSU students, staff and faculty, and by SBP scientists. Parameters to be evaluated include those most relevant to food, such as, nutrient and metabolite composition, bioma macro- and micro-structure, and textural analysis. The requested EPSCoR funds will support collaborative research among academia and industry in Montana, and would foster procurement of additional grant funds to advance this promising novel technology for space.