Fiscal Year:	FY 2023	**Task Last Updated:**	FY 09/14/2023
PI Name:	Wu, Martin		
Project Title:	Improvement of Shelf Life for Space Food Through Hurdle Approach		
Division Name:	Human Research		
Program/Discipline:			
Program/Discipline--Element/Subdiscipline:			
Joint Agency Name:		**TechPort:**	No
Human Research Program Elements:	(1) **HHC**:Human Health Countermeasures		
Human Research Program Risks:	(1) **Food**:Risk of Performance Decrement and Crew Illness Due to an Inadequate Food System		
Space Biology Element:	None		
Space Biology Cross-Element Discipline:	None		
Space Biology Special Category:	None		
PI Email:	chiheng.wu@nasa.gov	**Fax:**	FY
PI Organization Type:	GOVERNMENT	**Phone:**	
Organization Name:	KBR/Wyle - NASA Johnson Space Center		
PI Address 1:	2400 NASA Parkway		
PI Address 2:			
PI Web Page:			
City:	Houston	**State:**	TX
Zip Code:	77058	**Congressional District:**	22
Comments:			
Project Type:	GROUND	**Solicitation / Funding Source:**	Directed Research
Start Date:	12/01/2019	**End Date:**	03/31/2027
No. of Post Docs:	0	**No. of PhD Degrees:**	0
No. of PhD Candidates:	0	**No. of Master' Degrees:**	0
No. of Master's Candidates:	0	**No. of Bachelor's Degrees:**	0
No. of Bachelor's Candidates:	0	**Monitoring Center:**	NASA JSC
Contact Monitor:	Stenger, Michael	**Contact Phone:**	281-483-1311
Contact Email:	michael.b.stenger@nasa.gov		
Flight Program:			
Flight Assignment:	NOTE: Start date revised to 12/01/2019 from 10/01/2019 per discussions with PI and HRP (Ed., 8/2/21)		
Key Personnel Changes/Previous PI:	Summary as per PI (September 2023 Update): Research and reporting responsibilities were transferred from Takiyah Sirmons (October 2019) to Corunda T. Pruitt (March 2022) and then to Martin Wu (May 2023). May 2023--Martin Wu, Ph.D. has taken over the project as PI (Ed., 5/31/23) December 2019--With this continuation project, Takiyah Sirmons, Ph.D. takes over the project from Maya Cooper. Maya Cooper remains as CoInvestigator (CoI). Lea Mohr, who was CoI on the project with PI Cooper, has passed away.		
COI Name (Institution):	Froio-Blumsack, Danielle M.S. (U.S. Army Natick Soldier RD&E Center) Douglas, Grace Ph.D. (NASA Johnson Space Center) Young, Millenia Ph.D. (NASA Johnson Space Center) Wu, Chi Heng (Leidos)		
Grant/Contract No.:	Directed Research		
Performance Goal No.:			
Performance Goal Text:			

Task Description:	[Ed. note 12/13/2019: Continuation of "Improvement of Shelf Life for Space Food Through Hurdle Approach" with Principal Investigator (PI) Maya Cooper, due to PI Cooper relocating within Human Research Program at Johnson Space Center.] September 2023 Update: The sensory protocol was expanded in 2020 - 2022 to accommodate social distancing protocols in response to COVID-19. Social distancing protocols and associated budget was not included in the sensory protocol starting in FY24. Most items of the current space food system will not achieve the minimum 5-year shelf life required for a Mars mission due to decrements in nutritional quality or sensory acceptability. Previous Advanced Food Technology (AFT) studies have shown critical losses in some nutrients in a number of space food products after 3 years of ambient storage [Cooper project, “Effects of Processing and Subsequent Storage on Nutrition (PI Cooper)”], unacceptable losses in quality after 3 years [Catauro, P.M. & Perchonok, M.H. Assessment of the long-term stability of retort pouch foods to support extended duration spaceflight. Journal of food science (2012) 77, S29-39], and the inability of individual processing and storage solutions to achieve a projected 5-year shelf life (Cooper project “Integration of Product, Package, Process, and Environment: A Food System Optimization”). This task will investigate the use of hurdle approach to increase the shelf life of the current space food system, as well as assess the stability a supplemental component food system (homogeneous, shelf-stable foods and an assortment of condiments) stored under similar conditions. The study will produce the 5-year data essential to fully inform the state of a Mars food system and indicate the best countermeasures to nutritional and sensory degradation. Putting a 7-year data option in place initially will ensure that the PRR is not unnecessarily extended by several years if it is determined at that time that a longer-term shelf life study was necessary to determine mission requirements. Specific Aims: Determine how reduced storage temperatures (-80C, -20C, 4C) and alternative processing and packaging impact the quality and nutrient concentrations of space food over a 5-7 year shelf life period as compared to the quality and nutrient concentrations of space food produced under traditional methods and stored at ambient temperature (21C).
Rationale for HRP Directed Research:	
Research Impact/Earth Benefits:	The Advanced Food Technology Project (AFT) aims to develop the requirements for a food system that will provide the crew with a safe, nutritious, and acceptable food system while remaining within the constraints of available vehicle resources such as mass, volume, and crew preparation time on exploration missions (Cooper et al,. 2011). The food system on the International Space Station is composed of prepackaged thermally stabilized foods, irradiated foods, freeze-dried foods, intermediate moisture or bite sized foods, and powdered drinks, all stored at ambient conditions (currently 21ºC) due to resource constraints. In the case of long exploratory missions, this same prepackaged food system could continue as the primary food system. The longer mission requires the food system to sustain the crew for three to five years without replenishment. However, many of the space menu items do not maintain acceptability or nutritive value for a five-year period using current stabilization strategies (Catauro and Perchonok 2012, Barrett and Cardello 2012). Sensory acceptability is critical to ensure crew maintain adequate levels of consumption. Inadequate food acceptability has been linked to decreased food consumption, which may affect crew nutrition and psychosocial health and limit the crew’s ability to complete mission-critical tasks (Friedl and Hoyt 1997). The adequacy of the food system becomes increasingly important in the harsh environments of isolation and confinement, where other comforts and familiarities are unavailable (Stuster 2000). The processed and prepackaged space food system is the main source of crew nutrition, and hence is central to astronaut health and performance. Unfortunately, space food quality and nutrition degrade to unacceptable levels in 1 to 3 years with current food stabilization technologies. Future exploration missions will require a food system that remains safe, acceptable, and nutritious through 5 years of storage within vehicle resource constraints. This study assesses the potential of combining stabilization technologies (alternative storage temperatures, processing, formulation, ingredient source, packaging, food components and preparation procedures) to mitigate degradation of quality and nutritional content in space food. This update focuses on the aspects of sensory and nutritional stability of 33 foods and condiments through their current shelf-life timepoints, which varies between 3 and 5 years for each food.
Task Progress:	September 2023 Update: Forty-eight percentage of products tested (16 out of 33) require refrigeration or frozen storage to maintain acceptability and at least 80% of their original nutrition through their current interim testing date (ranging from 3-5 years). Trends do not currently indicate an added benefit from frozen storage over refrigerated storage, but testing will continue to confirm this trend through 5-7 years. NOTE: Per NASA-JSC, there is no additional progress to submit for this reporting period. The NASA Human Research Program has indicated that the project is presently on hold (Ed., 3/3/23).
Bibliography Type:	Description: (Last Updated:)