Fiscal Year:	FY 2017	**Task Last Updated:**	FY 10/28/2016
PI Name:	Cooper, Maya M.S.		
Project Title:	Functional Foods Baseline and Requirements Analysis		
Division Name:	Human Research		
Program/Discipline:			
Program/Discipline--Element/Subdiscipline:	HUMAN RESEARCH--Space Human Factors Engineering		
Joint Agency Name:		**TechPort:**	No
Human Research Program Elements:	(1) **HHC**:Human Health Countermeasures		
Human Research Program Risks:	None		
Space Biology Element:	None		
Space Biology Cross-Element Discipline:	None		
Space Biology Special Category:	None		
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Comments:			
Project Type:	Ground	**Solicitation / Funding Source:**	Directed Research
Start Date:	09/27/2013	**End Date:**	10/31/2016
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
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Flight Program:			
Flight Assignment:			
Key Personnel Changes/Previous PI:			
COI Name (Institution):	Douglas, Grace Ph.D. (NASA Johnson Space Center)		
Grant/Contract No.:	Directed Research		
Performance Goal No.:			
Performance Goal Text:			
Task Description:	NASA, in planning for long duration missions, has an imperative to provide the necessary nutrition to ensure sustainment of crew health and performance. To this end, the Human Health Countermeasures (HHC) Program has identified several desired nutrients, optimally delivered from food sources, with the potential to benefit health beyond nutritional maintenance. It is expected that these nutrients, and any nutrients identified in the future, will be required to be delivered in the food system to mitigate or prevent health issues, and that determination of compatible formulation, processing, and storage conditions will enable these functional foods to meet shelf life requirements. The purpose of this task is to determine the current concentrations of these previously unmeasured nutrients in the food system and their stability to different processing conditions, formulation matrices, and storage temperatures reflective of potential vehicle architecture to inform functional food capabilities and requirements development for long duration spaceflight. Milestones and Deliverables: The study duration was 3 years. Analysis of existing nutritional data, the assessment of additional nutrients in existing food over time, and characterization of food matrices encompassed much of the study		

	and occurred concurrently throughout the study. The final data will be provided in the Life Sciences Data Archive to assist fellow researchers with questions on feasibility of and food availability for functional food countermeasures in the spaceflight food system. At the conclusion of this task, researchers delivered a baseline assessment of functional foods within the current International Space Station (ISS) food system as well as provided requirements for the development of functional foods in the space food system.
Rationale for HRP Directed Research:	This research is directed because it contains highly constrained research.
Research Impact/Earth Benefits:	This research is on the forefront of establishing functional food concentrations in processed foods whereas the current research focus only considers whole, generally fresh, foods. The data will allow efforts for high nutrition to all populations regardless of access to fresh food. Consequently, the benefits of healthful diet can be extended as well.
Task Progress:	The task was completed in September 2016. This study evaluated the stability of certain bioactive compounds in existing International Space Station food provisions such that the feasibility of supplying functional foods within a space food system as a countermeasure to health and performance decrements health would be known. The status and stability of bioactive compounds in the processed and shelf-stable spaceflight food system has not previously been investigated though the presence of such compounds in foods at the end of a five-year shelf life could have health significance for crews on long exploration missions. Twelve foods that were predicted to have a significant concentration, or a concentration significantly greater than most spaceflight foods, of bioactive compounds (lycopene, lutein, omega-3 fatty acids, phenolics, sterols, and flavonoids) were selected for the study from the International Space Station (ISS) food provisions. Food samples were sent overnight to the Food Composition Laboratory of the Linus Pauling Institute at Oregon State University (Corvallis, OR) for bioactive compound analysis. Three packages of each product were blended together for the analysis to reduce package-to-package variability. Samples were analyzed initially and after 3, 6, 12, and 24 months of storage, dependent upon storage temperature (4°C, 21°C, or 35°C). Efficacious concentrations of lycopene, lutein, and omega-3 fatty acids were measured in limited spaceflight foods, but a meal plan addressing health issues requiring these compounds could not be created without a secondary risk of menu fatigue. Likewise, two grams of sterols a day may be difficult to achieve with the current space diet. Total polyphenol delivery appears stable and adequate, but individual phenolic compounds vary in stability and were not specifically evaluated in this study. The data suggests that some bioactive compounds, like lycopene and lutein, degrade and then plateau at some equilibrium concentration. The anthocyanin stability appears to be related to storage temperature and processing method, and lutein stability in leafy vegetables may be impacted by storage temperature. This work indicates that cold storage, increased variety, and processing optimization will be required to provide and sustain several bioactive compounds in current spaceflight foods. Implementation of countermeasures will require validation to five years to enable provisioning of an acceptable food system for a mission to Mars.
Bibliography Type:	Description: (Last Updated: 04/23/2019)
Abstracts for Journals and Proceedings	Bermudez-Aguirre D, Cooper MR, Douglas G, Smith S. "Development and provision of functional foods to promote health on long-duration space missions." Presented at 2016 NASA Human Research Program Investigators' Workshop, Galveston, TX, February 8-11, 2016. 2016 NASA Human Research Program Investigators' Workshop, Galveston, TX, February 8-11, 2016. https://ntrs.nasa.gov/search.jsp?R=20160001747 , Feb-2016