Delivery of Probiotics in the Space Food System
S. L. Castro, C. M. Ott, G. L. Douglas
NASA, 2101 NASA Parkway, Houston, TX 77058

Enumerate

ABSTRACT

The addition of probiotics to the space food system is expected to confer immunostimulatory benefits on crewmembers during spaceflight, counteracting the immune dysregulation that has been documented in spaceflight [1]. Specifically, the probiotic Lactobacillus acidophilus has been shown to promote health benefits including antagonism towards and inhibition of virulence related gene expression in pathogens, mucosal stimulation of immune cells, and a reduction in the occurrence and duration of cold and flu-like symptoms [2-5]. The optimum delivery system for probiotics has not been determined for spaceflight, where the food system is shelf stable and the lack of refrigeration prevents the use of traditional dairy delivery methods. This work proposes to determine whether L. acidophilus is more viable, and therefore more likely to confer immune benefit, when delivered in a capsule form or when delivered in nonfat dry milk powder with a resuscitation opportunity upon rehydration, following 0, 4, and 8 months of storage at -80°C, 4°C, and 22°C, and both prior to and after challenge with simulated gastric and intestinal juices. We hypothesize that the low moisture neutral dairy matrix provided by the nonfat dry milk, and the rehydration step prior to consumption, will extend probiotic viability and stress tolerance compared to a capsule during potential storage conditions in spaceflight and in simulated digestion conditions.

OBJECTIVES

Determine the viability of L. acidophilus that is added to non-fat dry milk and rehydrated prior to consumption or provided in a capsule through eight months of storage at -80°C, 4°C, and 22°C and exposure to simulated digestion conditions.

METHODS

Treatments

RESULTS

Currently, only the initial analysis (shelf life Time 0) has been completed. All remaining samples are currently in controlled storage under described conditions.

DISCUSSION

The capsule material disintegrated in both simulated small intestinal and gastric juice in less than 20 minutes with manual agitation (performed in duplicate), exposing the injured dry probiotic cells directly to the extreme pH conditions and enzymes of each environment. Gastric exposure could be several hours in length [7], and cells are required to make it through digestion and thrive in the small intestine where they are expected to interact with the microbiome and human cells to provide their beneficial effects.

Survival of L. acidophilus in milk through challenge with simulated gastric and small intestinal juice supports the hypothesis that the dairy matrix provides protection to the cells.

Rehydration in PBS indicated that rehydration alone did not improve L. acidophilus survival in simulated small intestinal conditions, but did provide protection in simulated gastric conditions. It is suggested that the proteins in milk provided more efficient buffering capacity in all conditions compared to PBS.

Current results indicate that probiotics will be more effectively administered in an appropriate food matrix than in a capsule.

Future Work

This work will be repeated on replicate samples following 4 and 8 months of storage at 22°C.

Additionally, replicates will be enumerated following 4 and 8 months of storage at -80°C and 4°C to indicate the benefit of colder temperatures to probiotic provisioning for long duration missions.

This data will inform provisioning strategies for probiotics, and inform mission planners of storage requirements to probiotic survival trade-offs.

References