Meal Replacement Mass Reduction and Integration Acceptability Study

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Abstract

The Orion Multi-Purpose Crew Vehicle (MPCV) and future exploration missions are mass constrained; therefore we are challenged to reduce the mass of the food system by 10% while maintaining safety, nutrition, and acceptability to support crew health and performance for exploration missions. Meal replacement with nutritionally balanced, 700-900 calorie bars was identified as a method to reduce mass. However, commercially available products do not meet the requirements for a meal replacement in the spaceflight food system. The purpose of this task was to develop a variety of nutritionally balanced, high quality, breakfast replacement bars, which enable a 10% food mass savings.

To date, six nutrient-dense meal replacement bars have been developed, all of which meet spaceflight nutritional, microbiological, sensory, and shelf-life requirements. The four highest scoring bars were evaluated based on final product sensory acceptability, nutritional stability, qualitative stability of analytical measurements (i.e. color and texture), and microbiological compliance over a period of two years to predict long-term acceptability. All bars maintained overall acceptability throughout the first year of storage, despite minor changes in color and texture. However, added vitamins C, B1, and B9 degraded rapidly in fortified samples of Banana Nut bars, indicating the need for additional development.

In addition to shelf-life testing, four bar varieties were evaluated in the Human Exploration Research Analog (HERA), campaign 3, to assess the frequency with which actual meal replacement options may be implemented, based on impact to satiety and psychosocial measurements. Crewmembers (n=16) were asked to consume meal replacement bars every day for the first fifteen days of the mission and every three days for the second half of the mission. Daily surveys assessed the crew's responses to bar acceptability, mood, food fatigue and perceived stress. Preliminary results indicate that the majority of crew members were noncompliant with daily meal replacement during the first half of the mission. Several crew members chose to forgo the meal, resulting in caloric deficits that were higher on skipped-bar days. Body mass loss was significant throughout the mission. Although there was no significant difference in body mass loss overall between the first half and second half of the mission, a higher number of individual crew members lost more body mass in the first half of the mission.

Analysis is still ongoing, but current trends suggest that daily involuntary meal replacement can lead to greater individual impacts on body mass and psychological factors, while meal replacement on a more limited basis may be acceptable to most crew for missions up to 30 days. This data should be considered in Orion mass trades with health and human performance.