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Author: Ms. Roxanne Fournier
University of British Columbia, Canada, roxyfournier@gmail.com

Dr. Aaron H. Persad
Massachusetts Institute of Technology (MIT), United States, persadaa@mit.edu

A LOW-COST ADAPTER FOR THE REHYDRATION OF COMMERCIALLY AVAILABLE FOOD AND BEVERAGES FOR SPACEFLIGHT

Abstract

All current rehydratable food and drink items prepared for U.S. astronauts on missions to the International Space Station (ISS) must be compatible with the station's potable water dispenser, called the rehydration station. This highly validated system ensures that water is compartmentalized and safely transferred to custom-made food and beverage pouches to prevent free-floating food particles and water in microgravity. However, the food and beverages packaged in these single-purpose pouches require complex, time-consuming, and costly procedures before flight, which is not feasible for future commercial space stations seeking more affordable life-support systems. Furthermore, even though a vast number of rehydratable food and beverage items available at supermarkets have appropriate nutritional content and shelf life for spaceflight, their incompatible consumer packaging renders them unusable by astronauts. In this paper, we present a low-cost solution that draws on NASA technology to adapt these commercially developed food and drink items for spaceflight and makes them compatible with the water dispensing unit and consumption in a microgravity environment. The 3D-printed adapter is based on the NASA septum adapter with the addition of a piercing end and one-way barb that stabilizes the adapter inside the food pouch and ensures it is not released due to the force generated by the water when it is dispensed. The dimensions of the adapter are 20(L) x 10(W) x 30(H) mm. The design is compatible with two types of packaging commonly used for commercially available rehydratable foods: laminated MylarFoil (MF) and kraft paper with aluminum lining (KP). Based on these two packages, we present a table of commercial items that could be available to astronauts if the adapter were to be used. To validate the adapter's use in the space environment, we also present data on the structural properties against typical loads experienced during launch and re-entry, as well as a functionality test to determine rehydration effectiveness, and a human factors assessment based on user feedback. The results show that the new adapter meets the specifications required for spaceflight and is more effective at piercing the KP compared to MF. This is because MF requires a lower force to propagate a tear which could lead to failure of the packaging to contain the food or beverage once pierced by the adapter. In summary, the adapter is an effective method to increase menu diversity while simultaneously eliminating costs associated with space food preparation and re-packaging.