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Abstract

Summary: Food preservation, including food waste management, is a serious concern for astronauts in space and deep space travel. This research suggests fermentation as a food waste management system in space. This process is one of the oldest forms of food preservation. In addition to its Earth-based benefits, the fermentation process could be used to support life in space. The application of the fermentation process will allow for the reuse of food industry waste for a closed loop system in space, the preservation of limited fresh ingredients, including the diversification of food choices, the cultivation of nutrients and also the improvement of the health of the astronaut's intestines.

Fermentation is the conversion of food by microorganisms, and fermentation can be used to contribute to rational waste management by preserving the nutritional value of fresh ingredients, repurposing food waste, and growing new food and target nutrients. This process will be coordinated to optimize the fermentation process in indoor environments with near-term benefits. This early-stage research update highlights the possibilities of bringing the rich culture of Earth-based fermentation practices such as miso, garum, and others into space to develop efficient applications for astronauts and new ways to manage food waste. In order to manage food waste in a rational way, a prototype for a miniaturized fermentation chamber was developed to directly control fermented food products and collect information.

The camera is equipped with sensors to collect environmental data, including radiation, temperature, gas, volatile organic compounds, humidity, pressure, and carbon dioxide readings, as well as observable visual changes. As such, expanding space-ready food innovations, it will be designed for possible future deployment and integration with the International Space Station. Along with this apparatus, modern programs for space food products and new recipes based on the fermentation process are being developed. A prototype of this research has already been developed and also tested. In this initial experiment, a sample of miso (a nutrient-rich fermented soybean paste) was sent to the International Space Station for a 1-month internal mission, where it was compared to control samples on the ground. Thus, the samples were stored in individual chambers fully equipped with the aforementioned sensors. With the help of the experiment and the evolution of hardware platforms, it is aimed to study what ecological changes occur in bacterial and fungal populations, and also to improve a standardized process and toolkit for space fermentation.