SAMPLE

Cosmic Explorers: Space Food

How Astronauts Eat in Orbit

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Free sample: Introduction & Chapter 1

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This free sample contains the Introduction and Chapter 1. The complete book contains the full contents above.

Introduction

Space food is a type of food product created and processed for consumption by astronauts during missions to outer space. Such food has specific requirements to provide a balanced diet and adequate nutrition for individuals working in space while being easy and safe to store, prepare and consume in the equipment-filled weightless environments of crewed spacecraft. Space food is commonly freeze-dried to minimize weight and ensure long shelf life. Before eating, it is rehydrated.

Unmodified food, such as items of spirulina, fruit, and even a sandwich, have been brought into space. Packaging varies, including tubes, cans, and sealed plastic packages. In recent years, space food has been used by various nations engaging in space programs as a way to share and show off their cultural identity and facilitate intercultural communication.

Although astronauts consume a wide variety of foods and beverages in space, the initial idea from The Man in Space Committee of the Space Science Board in 1963 was to supply astronauts with a formula diet that would provide all the needed vitamins and nutrients. There are several classifications of space food, as follows:

Freeze dried drink mixes (coffee or tea) or flavored drinks (lemonade or orange drink) are provided in vacuum-sealed beverage pouches. Coffee and tea may have powdered cream and/or sugar added depending on personal taste preferences. Empty beverage retort pouches are provided for drinking water. Fresh Foods (FF) Fresh fruits, vegetables, and tortillas delivered by resupply missions. These foods spoil quickly and need to be eaten within the first two days of the package's arrival to the ISS to prevent spoilage.

These foods are provided as psychological support for astronauts who may not return home for extended periods of time.

Fresh fruits, vegetables, and tortillas delivered by resupply missions.

Beef steak that is sterilized with ionizing radiation to keep the food from spoiling. NASA has dispensation from the U.S. Food and Drug Administration (FDA) to use this type of food sterilization. Intermediate Moisture (IM)

Foods that have some moisture but not enough to cause immediate spoilage. Examples include sausage and beef jerky. Natural Form (NF)

Commercially available, shelf-stable foods, such as nuts, cookies, and granola bars, that are ready to eat.

Foods that have been dehydrated by various technologies (such as drying with heat, osmotic drying, and freeze drying) and allowed to rehydrate in hot water prior to consumption. Reducing the water content reduces the ability of microorganisms to thrive. Thermostabilized (T)

Also known as the retort process, this process heats foods to destroy pathogens, microorganisms, and enzymes that may cause spoilage. Extended shelf-life bread products

Scones, waffles, and rolls specially formulated to have a shelf life of up to 18 months.

More common staples and condiments do not have a classification and are known simply by the item name. Designing food for consumption in space is an often difficult process. Foods must meet a number of criteria to be considered fit for space. Food must be physiologically appropriate, in that it must be nutritious, easily digestible, and palatable. Secondly, the food must be engineered for consumption in a zero-gravity environment.

As such, the food must be light, well packaged, fast to serve, and require minimal cleaning up. Finally, foods require a minimum of energy expenditure throughout their use; they must store well, open easily, and leave little waste behind (foods that tend to leave crumbs, for example, are ill-suited for space). Carbonated drinks have been tried in space but are not favored due to changes in belching caused by microgravity.

Without gravity to separate the liquid and gas in the stomach, burping results in a kind of vomiting called "wet burping". Coca-Cola and Pepsi were first carried on STS-51-F in 1985. Coca-Cola has flown on subsequent missions in a specially designed dispenser that utilizes BioServe Space Technologies hardware used for biochemical experiments. Space Station Mir carried cans of Pepsi in 1996.

Chapter 01: The Discovery of Space Food

The first eating in orbit was less a meal than an engineering demonstration, food treated as a payload with the same constraints as any other system on the ship. The early menus sorted everything by process: rehydratable foods, frozen and vacuum-dried, brought back to life with hot water; thermostabilized foods, cooked sealed in their pouches the way canned goods are cooked, the heat destroying every pathogen and enzyme that could spoil a meal months from any kitchen. Even the bakery items were engineered, scones and rolls formulated to stay acceptable on the shelf for a year and a half. Beer has also been developed that counteracts the reduction of taste and smell reception in space and reduces the possibility of wet burps in microgravity.

A parabolic flight experiment using Vostok, a specially-produced stout by Four Pines, validated that the reduced carbonation recipe met the criteria intended for space. Barley harvested from crops grown for several generations in space has also been brought back to Earth to produce beer. While not a space food (it used the same high carbonation 'Earth' recipe), the study did demonstrate that ingredients grown in space are safe for production. Space bread has proved elusive because of a variety of challenges.

By 2012 a method was suggested where the dough is leavened by dissolved CO2 (as opposed to yeast) and cooked by a low-temperature process, which could allow for fresh bread to be baked from bulk ingredients on future spaceflights. The primary purpose of packaging space food is preserving and containing the food. However, the packaging must also be light-weight, easy to dispose of and useful in the preparation of the food for consumption.

The packaging also includes a bar-coded label, which allows for the tracking of an astronaut's diet. The labels also specify the food's preparation instructions in both English and Russian. Many foods from the Russian space program are packaged in cans and tins. These are heated through electro-resistive (ohmic) methods, opened with a can-opener, and the food inside consumed directly. Russian soups are hydrated and consumed directly from their packages. NASA space foods are packaged in retort pouches or employ freeze drying.

They are also packaged in sealed containers which fit into trays to keep them in place. The trays include straps on the underside, allowing astronauts to attach the tray to an anchor point such as their legs or a wall surface and include clips for retaining a beverage pouch or utensils in the microgravity environment. The International Space Station is fitted with rehydration chambers and food warmers to prepare the packaged food before consumption.

The first galley on ISS was located in the Russian Orbital Segment (ROS), containing a hydration system for reheating food, and a food warmer for canned food. The United States developed the second food warmer system in a briefcase-like shape to provide the reheating function for packet-style food items. A second galley was added to the Unity module due to the crew size increase.

Combined dinners were rare, as Russian, Space Shuttle, and other ISS astronauts were often eating in their own segments with different schedules. On Tiangong Space Station, the kitchen is located in the Tianhe core module, along with living quarters and entertainment systems. The kitchen is equipped with a small table for food preparation and the first-ever microwave oven in spaceflight.

Huang Weifen, the chief astronaut trainer of China Manned Space Agency (CMSA), explained that the intention was to make sure that astronauts can "always have hot food whenever they need." China later experimented with using convection oven in space. Shenzhou 21 delivered an air fryer to the Tiangong, which features built-in air purification and residue collector to allow safe usage inside confined space and microgravity. The new oven allows baking and grilling of food, instead of simple reheating.

Chinese astronauts cooked barbecue chicken wings and grilled steak with it.

Early space food was primarily composed of bite-sized cubes, freeze-dried powders, and thick liquids stuffed in aluminum tubes. First used on the 3rd Mercury mission in 1962, US astronaut John Glenn was the first to eat directly from an aluminum tube, specifically applesauce.

With the introduction of the "spoon bowl," on the Apollo 8 mission, astronauts were able to open the contents of the package and eat the simple meal with a spoon. For lunch on Vostok 1 (1961), Yuri Gagarin ate from three 160 g (5.6 oz) toothpaste-type tubes, two of which contained servings of pureed meat and one which contained chocolate sauce.

End of free sample. The full book is available at putrabooks.github.io

ABOUT THE AUTHOR

Aira Astralis is a science writer specializing in astronomy and space exploration. Her work spans the full breadth of humanity's relationship with the cosmos -- from the earliest naked-eye observations to the engineering marvels of modern space missions.

Her books are built on a foundation of primary sources: peer-reviewed research, mission archives, and direct engagement with the scientific community. She writes for readers who want to understand not just what we know about the universe, but how we came to know it.

She believes that the most important frontier is not out there but in the gap between what scientists discover and what the public understands. Her books exist to close that gap.