

Space

Overview

Food is an essential component in human space exploration. If it had not proved possible to eat and digest in space, none of the longer-term space missions since the 1960s would have been achievable. Space travel has such a significant impact on the body that good nutrition is critical. Bone density decreases; muscles waste; cardiovascular deconditioning occurs; red blood cells are lost. Space sickness affects more than half of all astronauts, regardless of experience; and exposure to high levels of radiation can increase susceptibility to other problems such as cataracts and cancer later in life. Space conditions—in particular, the shift of fluid to the head and a low intake of zinc—impact the senses of smell and taste, both of which are reduced, making stimulation of the appetite more difficult. At the same time, the cramped, stuffy, smelly, and noisy conditions on board the spacecraft conspire to dampen the appetite further. Early on, the astronauts would return to Earth thinner and weaker—and with a large proportion of their allotted food uneaten.

Major Foodstuffs

Every aspect of eating in space must be planned months ahead of any meal being eaten. Minimal quantities of fresh food can be taken into space, so seasonality is not a consideration. Rather, an approved list of pre-prepared foods are tasted by the astronauts, their selections are made, and menus for the complete mission are constructed for each one of them. Nutritional balance is an important consideration in the design of each menu, as is the need to ensure that favorite foods—including snacks like M&Ms—are included in sufficient quantities to keep morale boosted throughout the trip.

Exactly what the foods on the menu are depends largely on the space program. The Chinese *yuhangyuan* don't eat with chopsticks, but they do eat a recognizable Chinese cuisine with rice, meats, and vegetables in classic sauces of bean, chili and Sichuan pepper (kung pao chicken), or garlic, and fruit dishes; the Soviet Union's space program supplied Russian favorites like borscht (beet soup), pickled herring, and porridge; and the United States' food teams made sure they developed classic meat and vegetable dishes like chicken à la king and mashed potatoes, as well as hamburgers, hot dogs, and Thanksgiving dinners. The impact of space conditions seems to make most travelers crave strong flavors, so sauces are popular with every visitor—fresh onions and garlic for the Russians and chili sauce for the Americans.

Cooking

Astronauts open cans and packets and rehydrate and reheat fully pre-prepared meals. Storage problems and lack of refrigeration mean that there is little or no fresh food except at the very beginning of a mission or immediately after a resupply visit, but even if ingredients were available, there is no kitchen and no equipment to process it with. Every space capsule is a closed environment, so the production of fumes, steam, or, worst of all, smoke, is best avoided. Historically, there was barely enough room to move, and even now interior space is limited

to a fairly tight 1,438 cubic yards (1,100 cubic meters) for six astronauts in the International Space Station. Making room for kitchen equipment would be an expensive undertaking, and it has never been a priority. The astronauts have a demanding work schedule, often cited as another important reason for freeing them from kitchen drudgery and providing ready-to-go convenience foods.

Everything that is consumed in space is prepared in advance—several months in advance—having been tested and tasted by the astronauts, who choose their menus as part of the preflight planning. The food is packaged carefully to minimize its weight and bulk and to reduce spoilage in the extreme and fluctuating conditions of space. The packaging often doubles as the serving dish, and a number of foods can be eaten straight from the package without the need for any utensils other than the scissors to open the bag.

The cooking techniques used on the ground vary according to the type of food being prepared. Historically, pureed foods in aluminum tubes, originally developed in the 1940s and 1950s for air force pilots who had to use pressurized headgear, were the archetypal space food for both the United States and the Soviet Union. Almost anything could be put into these containers, both savory and sweet. In the early 1960s, U.S. scientists put a lot of effort into developing bite-sized compressed foods, which were tested on some of the early Mercury missions. These foods were small, dehydrated cubes (coated in gelatins, starches, or oils to stop them from disintegrating) that would rehydrate in the mouth as they were chewed. They came in a number of flavors—bacon, cheese and crackers, toast, peanut butter, fruitcake—but it was hard to tell them apart without looking at the label. The astronauts found them unpleasant in the mouth and to the taste, and some of the coatings caused stomach upset, so they were discontinued.

Given the concerns about the weight and bulk of everything that is launched into space, dehydration has remained an important technique for preserving and preparing food for space travel. A wide range of freeze-dried meat- and vegetable-based meals were developed during the 1960s, first for the Gemini and then the Apollo missions. These foods were packed into plastic packages that would then have water injected into them before being massaged by hand to ensure even distribution of the water. The water used was a by-product of the fuel cells that operated the generators on board, but the Gemini capsule produced only cold water, which did little to increase the appeal of items like mashed potatoes. Apollo had warm water, which helped, although the need to knead the food probably did little for its texture and appearance. These types of foods continued to be developed and remain an important source of food on the Space Shuttle, and the range has increased to include fish dishes and breakfast foods as well as soups and casseroles and a variety of drinks provided in powdered form.

By the end of the 1960s there was another advance: thermostabilized wet meat products in plastic pouches or cans. These foods are heat-treated to destroy bacteria, in the same process as is used in normal canning. The Soviet Union used many canned foods on its missions from the earliest stages of the space race. It seems that the weight of the cans discouraged the United States from doing the same, so the development of the pouches was an important step forward in providing better and more familiar food for the astronauts. Thermostabilized foods are commonly warmed on board before being eaten with a spoon or fork. This type of packaging has become particularly used for fish, fruit, and puddings. More recently, irradiated food has been provided on the Space Shuttle. This technique helps to prolong the shelf life of smoked and fresh-cooked meats, fruit, and vegetables.

Bread has been variously provided in cans, pouches, and vacuum packs, all in an effort to reduce crumb production. Crumbs floating in a weightless cabin would, of course, be impossible to sweep up. The provision of tortillas instead of more traditional breads has helped overcome the crumb issue. The tortillas are preserved for up to 12 months by being packaged in a nitrogen atmosphere with an oxygen scavenger packet to ensure no mold can grow.

Everything prepared for space flight is given a technical name. "Intermediate-moisture" foods have long been a staple of the space larder and would

simply be described as dried fruit or jerky by a nonastronaut. “Natural-form” foods like M&Ms, nuts, or granola bars would, equally, simply be called by their own name anywhere but in space. The preparation required on the ground is limited to putting them into appropriate secure and portion-controlled packaging. Condiments like ketchup and chili sauce are provided in individual pouches, requiring no special preparation before launch; but pepper and salt must be liquefied (pepper in oil and salt in water) and put into dropper bottles.

Typical Meals

The meals devised for space fit into to a typical Western pattern of three meals (breakfast, lunch, and dinner) with snacks. However, it is not clear that every mission conforms to this pattern in the timing of its meals. The workload is extensive, and the impact of being in space can reduce the appetite. Many meals are eaten on the move, alone, and without really taking a break.

Gemini Mashed Potatoes

Most of the processing of space food demands industrial techniques that are impossible to replicate domestically. The keen experimenter is limited to using common foods available in the local supermarket and attempting to replicate the space experience by improvising appropriate packaging.

1 package dehydrated mashed potatoes

1 ziplock bag with label

1 syringe

Cold water (quantity according to instructions on original package)

Carefully tip the dehydrated potatoes into the ziplock bag. Seal the bag. Measure the water into the syringe. Inject water into the bag, as close to the seal as possible. Gently massage the bag until the water is evenly distributed and the potato is hydrated. Open one corner of the package and eat with a teaspoon.

For Apollo mashed potatoes, follow the same procedure, but rehydrate with warm water instead of cold.

Eating Out

Every meal in space is a meal eaten in—although every meal in some sense lies far beyond the ordinary. Astronaut Michael Collins apparently devised his own Michelin-style grading system for space food, awarding helmets rather than stars for the items he most enjoyed, although it is not clear that any of the items on the menu would have been award winning back on Earth.

The best way to get a space meal that might come close to eating in a restaurant seems to be to invite a French *spationaut* to join one. From their earliest collaboration with the Russian program to the present day, French chefs have devised delicious meals for spationauts to share with their colleagues on special occasions. Richard Filippi, a chef and cookery school teacher, worked on the first of these dishes in the mid- to late 1990s, developing magnificent delicacies for Mir. In 1996 Claudie Haigneré treated her fellow cosmonauts to beef daube, confit of duck with capers, pigeons in wine, and a rich tomato sauce, all washed down with wine from the Alsace. Filippi’s other dishes were sent to Mir with French spationauts throughout the 1990s: squid in lobster sauce, toffee rice pudding, and, most spectacular, whole quail cooked in wine sauce, then deboned, sliced, and reassembled (including its wings) into a 3.5-ounce can.

More recently, space tourism has given a boost to the idea of restaurant-quality food in space, with chefs like Emeril Lagasse and television cooks like Martha Stewart and Rachel Ray contributing ideas and recipes to the development teams. Bringing a feast to share with the crew has become a component of the experience for the visitor.

Looking further to the future, Michelin-starred chef Alain Ducasse has turned his attention to fine dining for a possible mission to Mars, devising exquisite vegetarian recipes from the foods that could be grown on board or at a base on Mars: Martian

bread with green tomato jam, spirulina gnocchi, tomato and potato mille-feuille. He's even said he would open a restaurant there, so perhaps there is hope for a future of eating very far out indeed.

Special Occasions

Creating an environment that can feel as much like home as possible is a tremendously important consideration for the crews, which means that providing familiar foods is the priority in food provisioning. Of course, occasional treats are part of fostering team spirit and boosting morale. The Soviet Union used to send caviar to the cosmonauts for New Year and birthday celebrations, and the United States developed Thanksgiving and Christmas meals for its astronauts in the Apollo program. Individual teams on long-term missions in space have developed their own traditional treat foods, like Shannon Lucid's Sunday night Jell-O parties with her colleagues on Mir in the mid-1990s.

Diet and Health

Health is a primary concern on all space missions, and every facet of the astronaut's physiology and metabolism is scrupulously monitored, especially given the unique circumstances of weightlessness and the tendency to lose muscle mass and experience other forms of fatigue. The dietary composition of space food is likewise carefully analyzed by nutritionists and naturally changes with the development of nutritional science over the decades since humans were first sent into space.

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Further Reading

Bourland, Charles T., and Gregory L. Vogt. *The Astronaut's Cookbook: Tales, Recipes and More*. New York: Springer, 2009

"Space Food." National Aeronautics and Space Administration.
<http://spaceflight.nasa.gov/living/spacefood/index.html>.