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Importance of Right Nutrition for the Astronauts of Deep Space

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Abstract

Essential food requirements for space food systems include food safety, palatability, safety, stability, variety, usability, and reliability. The space station administration always gives astronauts access to nutritious food like fruits, vegetables, and certain processed foods as a regular diet. The gravitational impacts are significantly reduced in a microgravity environment in deep space. As a result of microgravity, the eating implements like wise float away. The beverage packaging for the international space station is made of laminated foil and plastic. The article mainly talked about the food system engineering facilities and the classifications of space food according to their processing. The article also highlighted the standard menu in a space shuttle for American, Russian, and Chinese astronauts according to a pre-planned diet. There are various uses of food under the food processing system in the space shuttle, such as preparation and selection of food, planning, and serving of food, etc. Similarly, it is essential for extended shelflife food for Indian astronauts. Proper nutrition and food safety are critical for all astronauts to cope with deep space environments.

Keywords: Space food; Space food system; Astronauts' diet; Deep space food; Space nutrition.

INTRODUCTION

In space science, nutrition and dietetics have progressed significantly regarding total quality assessments (food safety), food systems, calorie assessments, nutrient selections, and deficiencies. In an article, Douglas, Zwart, and Smith explained that the toxicity of nutrients, the underestimation of calories, and improper preservation were significant issues. Still, these factors have recently been found to develop significantly. Palatability, safety, stability, variety, usability,and reliability are essential food criteria in space food systems.In the aspect of a daily diet, the space station authority always provides astronauts with fresh food such as vegetables, fruits, salads, and some processed food. They used to face challenges with fresh food due to the short shelf life of some of the food. Still, thermo stabilization, irradiation based sterilization, and other processes can help for the best nutrition.[1]

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Effect of microgravity:

The effects of gravity are considerably lessened in a microgravity setting. The evidence shows that it happens when a spaceship orbits the earth with all its cargo in free fall. Due to a process known as cohesion, comparable to the adhesion of a drop of water to paper, liquids bind meals together and stick to themselves in enormous bubbles when released from their containers. Special straws are employed for removing drinks released for drinks

within the space shuttle. The needs for related food systems, as well as the development of space food packaging and food selection, have all been greatly influenced by the impacts of microgravity. The eating utensils also float away due to microgravity when not used; the knife, fork, spoon, and scissors are fastened to magnets on the food plate.[2]

History of food consumption in the international space station

Foil and plastic laminate is used to create the international space station (ISS) beverage packaging. A study described an adapter connecting the galley or kitchen area to the box. With a pair of scissors, the top of the box is removed, and the food within is consumed with a fork or spoon. The Foods Systems Engineering Facility conducts research and development on food transported into space at NASA Johnson Space Center in the United States of America. Foods are evaluated for their nutritional content, flavor, storage and unpackaging characteristics, and freeze drying efficiency. Food samples are offered to astronauts for tasting. They employ a straight for ward form to score things on look, color, odor, flavor, and texture. Five months before the flight, astronauts choose their food. They are going to pick 30 days flight menus for the ISS. Utensils and containers must be held in place because everything wanders in a microgravity environment. The crew will keep the food in the galley of the international space station.[2]

MATERIALS AND METHOD

The article is a short communication reviewing the available information in the open access literature on Google Scholar and National Center for Biotechnology Information (NCBI) databases. The data was also searched on the National Aeronautics and Space Administration (NASA) website and published reports from 1995 onwards. The keywords included 'Space food system,' 'Space food,' 'Astronauts' diet,' 'Deep space food,'and 'Space nutrition' for information related to deep space food processing, safety, and nutrition received by astronauts.

RESULTS AND DISCUSSION

The article mainly talked about the food system engineering facilities and the classifications of space food according to their processing. The article also highlighted the standard menu in a space shuttle for Russian and Chinese according to pre-planned and American Astronauts as per special planning A, B, and C. There are various uses of food under the food processing system in the space shuttle provided below serially.[2]

Preparation of food: Rehydratable meals are used by hikers to reduce their weight carrying. Any weight heading into space increases the amount of fuel used during take-off. Foods that have been rehydrated also take up much less room on the space shuttle (ss).

Selection of food: About five months before taking off, astronauts choose their food for space. A unique taste panel has been set up for the astronauts to sample various dishes. Before traveling into space, they can use this to determine whether they enjoy the cuisine.

Planning and serving of food: When eating in space, astronauts utilize specialized trays to keep their utensils in place. There are chambers on the ISS food tray for holding unique bowl like containers. These packaging units resemble the single serving frozen food plates sold in supermarkets.

Fruits and vegetables: The most perishable items like carrots and celery should be eaten during the first 2 days of the space shuttle. Many latest tools and techniques are adopted to keep fresh fruit and vegetables usually taken in the space shuttle. Certain fruits and vegetables can have an extended shelf life of up to 60 days.

Effect of mold: On space flight missions lasting more than seven days, commercial tortillas experience spoilage issues. The requirement to create a shelf stable tortilla at room temperature has grown as mission length has increased. The amount of water that is available has to be decreased, and the pH has to be lowered to stop bacterial growth from creating a tortilla that would be shelf stable for space travel.

Waste materials: To minimize waste and mess, nuts, shelled nuts, and fruit liquids are included in the meal lists for the space shuttle and international space station. Water, a by product of the space shuttle fuel cells' electrical power, makes up most of the waste. To lessen the amount of rubbish entering orbit, trash compactors are already on flight and designed for the space station.

Dehydration of food: Dehydrated foods and beverages make up a sizable portion of the space shuttle's daily dishes. Most water in nutrition is removed through freeze drying and other drying processes. This meal type adds variety to the menu for space travel and offers a more substantial diet. The fuel cells produce water as a by product, which makes water readily available for space shuttle

preparation. In the table 1. various food available for the space shuttle and international space station has been discussed with their basic descriptions and examples. These are ways by which food is usually preserved and processed for the consumption of astronauts who are also concerned with a non-boring diet. However, there have been drastic changes over the last two decades in food technology that are helping give quality food, taste, and flavors to eliminate the astronauts' boredom.

Table 1: Various space food and their preparation for regular consumption.

Types of food	Description	Examples
Fresh Food	Not artificially preserved and processed	Banana, apple
Refrigerated Food	To prevent microbial spoilage, need to chill the temperature	Cream cheese
Rehydratable Food	Dehydration (also known as freeze-drying) process. Food and drinks are prepared in this way.	Oatmeal as a hot cereal
Natural Form Food	Ready-to-eat (RTE) food is usually packed in easypackets.	All cookie nuts
Irradiated Food	The food is packed quickly after cooking in the foil packets.The ionizing radiation process is used for sterilization.	Smoke turkey
Frozen Food	The food is quickly chilled to stop building the large ice crystals.	Chicken pot pie, quiches
Thermostabilized Food	Hot process food can retain at standard temperature and is usually thermostabilized in a can.	Pudding in a cup, packed tuna fish.
Intermediate Moisture Food	Foods with intermediate moisture are kept fresh by removing a portion of the water while saving enough to preserve the product's soft texture. There is no need to prepare food to eat it.	Apricot, pear

A standard menu is presented, usually scheduled as a diet in a space shuttle for the American astronauts in table 2. A 2 days menu out of 7 days has been provided below in models A, B, and C, the three meals in the SS. After America, Russia, and China have significant roles in deep space work. Their usual consumable and preferred food have also been discussedat the table 3. Chinese like to consume their traditional food apart from processed space food listed below, according to *Tang et al*.[3]

Table 2: Standard menu ina space shuttle for American Astronauts (2 days).[3]

Days	(A)	(B)	(C)
Day-1	• Dried peaches (359) • Cornflakes (357) • Orange-pineapple drink (113) • Cocoa beans (220)	• Ham sand witch (257) • Cheese spread (295) • Tortilla x 2 (474) • Pineapple slices (50) • Cashews (553) • Strawberry drink (53)	• Chicken a la king (71) • Turkey Tetrazzini (150) • Cauliflower with/cheese (79) • Brownie (466) • Grape drink (67)

Day-2	• Scrambled eggs (182/2 pcs) • Dried pears (359) • Vanilla instant Breakfast (171) • Orange juice (45) • Beef Patties (247)	• Apple/grape Jelly (53) • Tortilla x2 (474) • Fruit cocktail (46) • Peach/apricot drink (70) • Trail mix (462)	• Macaroni and cheese (164) • Peach ambrosia (39) • Green beans with/ Mushrooms (59) • Frankfurters (290) • Tropical punch (35)

Table 3: Standard menu in a space shuttle for Russian and Chinese Astronauts (2 days a week). [3]

Day	Meal (1)	Meal (2)	Meal (3)
Russia	• Dried Peaches/Apricots (359) • Orange-Pineapple Drink (113) • Tvorog with tomatoes (138) • Other side dishes	• Chicken rice, lamb with vegetables (250) • Canned drinks (41) • Fried rice, shrimp/macaroni (262) • Other side dishes	• Beef with barley (56) • Canned Drink (42) • Fried rice withsturgeon (298) • Other side dishes
China	• Lotus seeds porridge (89) • Green tea (1) • Dried pears (262) • Beef patties (247) • Other traditional food	• Eight treasure rice (74) • Beef in soya sauce/beef balls (202) • Kung pao chicken (129) • Sichuan pork (271) • Other Traditional food	• Hot Pot (62) • Sweet and sour pork (270) • Ma Po tofu (119) • Ink fish balls (107) • Fried rice (163) • Other traditional food

Indian space food system focuses the proper nutrition.

In India, the Defence Food Research Laboratory (DFRL) has already started to prepare dried and packaged food. Laboratory testing has confirmed variously processed and dehydrated food varieties' good shelf life (nil micro-bacterial effect). A digital magazine that packaging, preservation, additives, and on-time supply are considered more seriously to reduces poilage for the best nutrition of astronauts. Even in challenging situations, the latest liquid dispensing and waste disposal systems, rehydrating food systems, and heaters are considered the best food management tools.[4]

CONCLUSIONS

Proper nutrition is essential for deep space astronauts because their job is quite challenging. The entire food system and safety process have significantly progressed compared to the 20th century. The leading countries' space food systems are paying great attention to technology based food engineering for space food planning, preparation, serving, preservation, and wastage systems. The ultimate benefits should come for the deep space workers to cope with the microgravity and other physical cum psychological aspects.

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