Space nutrition: The key role of nutrition in human space flight

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Types of Space Food

**Rehydratable Food** - The water is removed to make them easier to store.

**Thermostabilized Food** are heat processed so they can be stored at room temperature.

**Intermediate Moisture Food** are preserved by taking some water out of the product while leaving enough in to maintain the soft texture.

Food quality and Food availability
• **Natural Form Food**: These foods are ready to eat and are packaged in flexible pouches like nuts, granola bars, and cookies.

• **Irradiated Food**: Beef steak and smoked turkey are the only irradiated products being used at this time.

• **Frozen Food** are quick frozen to prevent a buildup of large ice crystals.

• **Fresh Food** are neither processed nor artificially preserved. Examples include apples and bananas.

• **Refrigerated Food**: These foods require cold or cool temperatures to prevent spoilage.
Impact of microgravity on astronauts

Some of the **health issues** related to microgravity include

- Bone loss
- Muscle atrophy
- Vision Impairment and Intracranial Pressure
- Cardiac dysrhythmias
- Blood vessels, and nerves
- Immune system
- Altered orientation
- Energy requirements; physiological changes in taste and satiety;
Space flight nutrition

Macronutrients like fat, protein, and carbohydrate

Micronutrients like vitamins and minerals

• Integration of Vitamin D levels during spaceflight.

• **Cal**ium and **Vitamin D** are very important for your bones, in part because vitamin D helps your body use the calcium in your diet.

• **Vitamin K** helps bones make proteins that hold calcium in place.

• Sodium intake has to be monitored during spaceflight, because space diets tend to have relatively high amounts of sodium.

Increased dietary sodium is associated with increased amounts of calcium in the urine and may relate to the increased risk of kidney stones.
Vegetables and fruits intake to increase antioxidant effects and contrast radiation exposure

• Every single vitamin is crucial for human body to function
• Thiamin, riboflavin, niacin, vitamins B-6 and B-12, folate, biotin, and pantothenic acid are essential
• Vitamins A, B12, C, D, E, K, etc. as well as mineral salts could be used in future as countermeasures for the radiation exposure of deep space during long-duration space missions.
Astronaut Microbiome characterization

• The composition of the **human microbiome changes during long-term space exploration** and to evaluate its potential impact on Astronauts' health.

• Some **microbial species** from the human microbiome have a **beneficial or protective effect on health**; the loss of these species can lead to an altered metabolic function
Fresh food project on ISS

• NASA set-up Veggie technology aboard the space station to provide future pioneers with a sustainable food supplement.

• NASA moves toward long-duration exploration missions farther into the solar system, Veggie will be a resource for crew food growth and consumption.

• It also could be used by astronauts for recreational gardening activities during deep space missions.
Vegetable Production System (Veggie)

Crop of "Outredgeous" red romaine lettuce from the Veggie plant growth system

Shelves of plants that are grown hydroponically and then using electric light sources like red and blue LEDs
**Vegetable Production System (Veggie)**

- With the long-duration missions aboard the International Space Station (ISS), it has become clear that more emphasis needs to be placed on **improving human habitability**. The Vegetable Production System (Veggie) provides a means to supply crews with a **continuous source of fresh food** and a tool for relaxation and recreation.

- Veggie can support a variety of experiments used to determine how plants sense and respond to gravity. A portion of the crop plants are typically harvested and consumed by the crew members with the remaining harvest packaged and returned to Earth for further analysis.
Can Plants GROW with MARS SOIL?

**Essential Plant Nutrients**

- Macronutrients
  - Oxygen (O)
  - Carbon (C)
  - Hydrogen (H)
  - Nitrogen (N)
  - Potassium (K)
  - Phosphorus (P)
  - Calcium (Ca)
  - Magnesium (Mg)
  - Sulfur (S)

- Micronutrients
  - Iron (Fe)
  - Manganese (Mn)
  - Zinc (Zn)
  - Copper (Cu)
  - Molybdenum (Mo)
  - Boron (B)
  - Chlorine (Cl)

= detected on Mars soil, or in Martian meteorites

#JourneyToMars
Crop production on the moon surface

A “portable habitat” to set-up on the Moon
Space greenhouse facilities
The importance of fresh food in space

• "There is evidence that supports fresh foods, such as tomatoes, blueberries and red lettuce are a good source of antioxidants. Having fresh food like these available in space could have a positive impact on people's moods and also could provide some protection against radiation in space,"
CRISPR/Cas9 engineering plants for space

• Fast technologies that are robust, affordable and easy to engineer crops in space are needed.

• CRISPR/Cas9 engineering plants to help them adapt to harsh environments like those on Mars are bringing us closer to that reality

• Targeted genome modification of crop plants using a CRISPR-Cas system.

Wei Li et al. Nature Biotechnology 2013, Volume 31
• Genome editing in rice and wheat using an engineered type II CRISPR-Cas system.

Wei Li et al. Nature Biotechnology 2013, Volume 31
Conclusions

• It can be realistically predicted that nutritional balance and dietary adequacy will become increasingly important on future long-term space flights.

• Nutrition is an essential part of maintaining the endocrine and immune system, skeletal and muscle integrity, and the hydration status of the space crew.

• Further efforts will be implemented to ameliorate dietary adequacy and food safety in order to counteract deleterious physiological changes, psychosocial repercussions and microbiological hazards.

• Supplying food crop on deep space with biotechnology and CRISPR technologies and with new crop production techniques
Thank you for attention!

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