SPACE FOOD SYSTEM

FINAL DEGREE PROJECT, FOOD SCIENCE AND TECHNOLOGY- JUNE 2021

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OBJECTIVES

The general objective: to investigate the food system of space missions.

Specific objectives:

- To determine the types of processing to which food is subjected to be consumed in space, preserving the quality, safety and stability of the product.
- To identify the nutritional needs of astronauts to preserve an adequate state of health.
- To analyze which are the most suitable packaging materials to ensure food safety and quality.
- To evaluate the evolution of space foods and future prospects.

PROCESSING AND PACKAGING TECHNOLOGY

Table 1. Type of treatment, packaging and shelf life according to the food category

Food category	Processing	Packaging	Shelf life
Meat and fish	Thermostabilized	Flexible retort bag or aluminium can	2-3 years
	Irradiated		
Vegetables	Fresh	Edible film	1 week
	Lyophilization or dehydration	High barrier vacuum	1,5-2,5 years
Fruits	Fresh	Edible film	1 week
	Intermediate moisture	Vacuum sealed	1,5 years
	Lyophilization	High barrier	1,5-2,5 years
Beverages	Dehydration	High barrier with valve for rehydration	1,5-2 years
Cereal derived foods	Thermostabilized	Retort bag	2-3 years
	Dehydration	High barrier with valve for rehydration	1,5-2 years
	Natural form	Vacuum sealed	6 months-1 year
Egg products	Lyophilization	High barrier	1,5-2,5 year

NUTRITIONAL NEEDS AND PHYSIOLOGICAL CHANGES

Table 2. Recommended daily intake values in space and their importance during spaceflight.

Macronutrient	Importance in spaceflight
Protein	Essential amino acids. Deficiency: loss of muscle mass, weakness, tissue degradation.
Carbohydrates	Main energy source. Deficiency: ketosis, worse efficiency.
Lipids	High energy density, absorption of fat-soluble vitamins and contribution of essential fatty acids.
Omega-6	
Omega-3	
Fiber	Gastrointestinal function and decreases the incidence of constipation.
Micronutrient	**Importance in spaceflight**
Vitamin A	Antioxidant effect, minimizes oxidative stress.
Vitamin D	Deficiency: brittle or brittle bones
Vitamin E	Counteracts the damage of free radicals generated by radiation
Vitamin K	Bone health
Vitamin C	Antioxidant function, minimizes oxidative stress.
B6	Immune and neurological function.
Folate	Immune function
Calcium	Bone health
Potassium	Deficiency: muscle weakness, constipation and fatigue.
Magnesium	Bone health, prevention of hypocalcemia.
Sodium	Calcium homeostasis
Iron	Deficiency: altered intellectual activity and fatigue.
Phosphorus	Bone health
Manganese	Minimize oxidative stress.

FOOD SAFETY

Table 3. Environmental and surface microbiological testing for space food production by the Johnson Space Center

Analysis area	Samples
Surfaces	3 surface samples per day
Packaging material	Before use
Machinery	2 samples per day
Food	**Microorganism to be analysed**
No thermostabilized	Total aerobic count
	Coliforms, Coagulase positive *Staphylococcus*
	Salmonella
	Fungi and yeasts
Commercially sterilized products	No samples are analysed microbiologically

CONCLUSIONS

- Most of the food is heat sterilized, irradiated or freeze-dried, as they provide a longer shelf life.
- Fresh and natural foods have a psychological and hedonic role.
- The most commonly used materials for packaging are high-barrier containers and retort bags, as they hinder the diffusion of gases.
- HACCP system, Good Manufacturing Practices and analysis of the production areas and the processing environment.
- Nutrition is essential to maintain the immune system, skeletal and muscular integrity, decreasing oxidative stress, and improving gastrointestinal motility.