



NASA Food Technology Commercial Space Center

Nutrition in Space by Jean Anderson

BACKGROUND

It is critical to maintain the health of the astronaut in prolonged space travel. Health is sustained in part as a result of the astronaut's nutritional intake. Complete nutritional intake is simplest if the astronaut merely takes a pill or a nutritional supplement. Historically, the space program has utilized bite-sized cubes of a product that is high calorie and nutrient dense as well as products in a tube shape (ex: Space Food Sticks). During the early US missions (such as Gemini and Apollo) although there was enough food product on board to provide each astronaut ample calories and nutrients, the food products were not palatable, the astronauts stopped eating enough during the flight and, thus, lost weight. As space missions have become longer in duration, a great deal of research and testing have gone into the foods, product packaging, and retort methodology utilized in these missions to enhance palatability, acceptability, and variety resulting in increased nutritional health of the astronauts.

There are physiological changes the astronauts experience during space travel. These include:

- 1) Gastrointestinal changes occur that may impact appetite or nutrient absorption. For example, many experience gaseous stomach due to the inability of gases to rise. Chronic inactivity increases transit time in the gut.
- 2) Taste and odor sensitivity changes occur in most as a result of the nasal congestion that occurs during the flight. Although specific research on Earth does not support changes in taste and odor sensitivity, many crews report changes which could affect appetite and eating habits.
- 3) Fluid shifts have been noted in head congestion, in plasma volume (decreases during the early phase of the flight) and red blood cell concentration (increases due to decreased plasma volume; hematocrit).
- 4) Musculoskeletal changes occur related to lack of gravity and physical inactivity. The greatest amount of loss of muscle mass occurs during the first month, then levels off. However, skeletal loss appear to be related to length of flight.

The menus are planned in a six to eight day cycle with enough food on board the shuttle to ensure that the shuttle does not run out of food between launch-resupply-re-entry; in fact, the goal is to have a 45 day supply of food and beverages on board at all times. Each astronaut selects his/her entire

BACKGROUND (CONTINUED)

menu of three meals per day plus snacks prior to launch; then the selected products are prepared and packaged according to strict sanitary guidelines and stored in locker trays labeled arranged in order they are to be consumed. Fresh food is supplied (includes breads, some fruits and vegetables, tortillas, and breakfast rolls) but as you might imagine it does not last for the entire trip. Astronauts also are allowed to bring along some favorite foods like M&Ms, cookies, chips that they might desire during the trip. Many find that the menu items they enjoyed and selected prior to the space flight, taste different or are not satisfying once they are in flight—therefore, many will season foods with spicy condiments (A-1 Steak sauce, Picante Sauce, etc) or trade foods with others or make up intriguing food combination casseroles.

A computerized inventory management system is in use to keep track of food and beverage supplies on the space craft. This system also serves potentially as a method to track out of date items. The items are scanned as they are brought aboard both at the initial loading and during re-supply. Once a food container is emptied, a crewmember scans it, so the NASA ground crew can track the number of food containers emptied by each crew and thus obtain a close approximation of the quantity of food remaining on orbit. NASA makes no attempt to inventory each individual food package, as this would require far too much crew time.

The psychology of eating is a critical component in prolonged space travel. Eating includes the aroma, the texture, the sounds, and the preparation of a food in addition to chewing and swallowing the food. Many of the space foods are soft and free of crumbs. The foods are prepared by reconstituting with water or micro-waving to heat through. Because the living environment is small and confined, strongly aromatic foods are problematic. Some topics of concern related to the psychology of eating include:

- 1) How to keep eating pleasurable?
- 2) How to sustain interest in eating?
- 3) How to keep from feeling bored or routine with the meals and snacks (This is somewhat related to the lack of choice; although we really only eat a few of the billions of foods we have to choose from here on Earth—we do have a choice)
- 4) How to incorporate celebration or holiday foods?

At the beginning of prolonged space travel, astronauts were told exactly what to eat and exactly when to eat. For a variety of reasons, including lack of free choice in other aspects of living in space, the astronauts revolted. Now, the foods are merely labeled (and expiration dated so that the FIFO method will be used) and there is no longer the emphasis on meal/snack times or actual intake.

**BACKGROUND
(CONTINUED)**

Overall, one of NASA's food and nutrition goals is to provide adequate, nutritious, tasty foods for the astronauts with enough variability so as to not lose one's appetite due to tastebud boredom.

**STUDENT
LEARNING
OUTCOMES**

- Students will be able to:
- 1) formulate appropriate questions to determine food intake
 - 2) identify 5 earth-bound client situations when similar situations may occur
 - 3) understand the importance of psychosocial factors on food intake.
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**INSTRUCTIONS
GIVEN TO
STUDENTS**

Problem One:

Identify up to 5 scenarios here on Earth where your client may experience some of the same appetite and food intake changes as an astronaut. (some expected answers: cancer patient, patient with severe food allergies thus limited food options, patient w/ nerve damage to sensory organs (tongue, ear, smell))

Problem Two:

Using the following information calculate the recommended daily macro-nutrient needs of a female astronaut aged 34 YO who is 5 feet 2 inches and weighs 135 pounds and will be conducting 3 EVA sessions during a 40 day mission.

Answer: wt = 61.4 kg

Kcal: $1.6 (8.7(61.4 \text{ kg}) + 829) = 1.6 (1363.18) = 2181.1 \text{ kcal}$ for all days except the EVA days and end of mission days. EVA days and end of mission days = $500 \text{ kcal} + 2181.1 \text{ kcal} = 2681.1 \text{ kcal}$.

Protein (4 kcal/gm):: regular days—65.4 gm – 81.8 gm; EVA and end of mission days—80.4 gm – 100.5 gm

Carbohydrates (4 kcal/gm): regular days—272.6 gm – 300gm; EVA and end of mission days—335.1 gm – 368.7 gm

Fiber: 10-25 gm /day

Fat (9 kcal/gm): regular days--72.7 gm – 84.8 gm; EVA and end of mission days—89.4 gm – 104.3 gm

Fluid: regular days—3.3 liters; EVA and end of mission days—4 liters

**INSTRUCTIONS
GIVEN TO
STUDENTS
(CONTINUED)**

Recommended macronutrient intakes for missions 30 days to 1 year	
Nutrient	Recommendation
Energy	Based on the WHO (1985) equation: men: (18-30 yrs): $1.7 (15.3W+679) = \text{kcal/day required}$ (30-60 yrs): $1.7 (11.6W+879) = \text{kcal/day required}$ women: (18-30 yrs): $1.6 (14.7W+496) = \text{kcal/day required}$ (30-60 yrs): $1.6 (8.7W+829) = \text{kcal/day required}$ $W = \text{weight in kg. Note this accounts for moderate levels of activity. An additional 500 kcal/d is supplied on days of Extra Vehicular Activity or during the period when end of mission countermeasures are being conducted.}$
Protein	12-15% of calories
Carbohydrate	50-55% of calories
Fiber	10-25 g/d
Fat	30-35% of calories
Fluid	1.5 mL/kcal (>2 L/day)

Problem Three:

Using the macronutrient calculations from Problem Two, develop one “regular” day’s menu using 3 meals and 3 snacks.

Could do this as a team project, then required to do more days of menus—good technique to identify variety and planning concerns.

Assess menus for: serving size, condiments (and kcals, etc), variety, color/shape/texture variations, etc.

Problem Four:

4 astronauts have returned to Earth following a 50 day space mission. Adequate food and fluid supplies were sent on the mission to meet each astronaut’s nutrient needs. Each astronaut was allowed to take along additional “off-menu” foods totaling 5000 calories.

The computerized inventory management system of the food supplies failed on the 21st day of the mission, thus there was no method to track remaining supplies from Earth.

3 of the 4 astronauts have no serious complaints or concerns. Medical assessment of each astronaut upon return shows that these 3 astronauts have the expected decreases in body mass (about 1-5 %), total body water, muscle mass and performance, and bone mineral loss.

The 4th astronaut complains of weakness and malaise along with bone and joint pain. Examination reveals that he has a significant decrease in body mass (has lost 40 pounds), as well as skinfold measures show extreme

muscle atrophy in the upper arm and quadriceps region, and DEXA tests show hairline fractures throughout the spine.

While other members of the healthcare team are tending to the unhealthy astronaut, it is your job to question him to rule out deliberate inadequate nutrient intake and eating habits during the space trip.

This can be performed in groups of three—one person is the RD asking the questions, the other is the astronaut, the other is observing the questioner for clarity, open-ended questions, etc. (Or can be individual where the person merely identifies questions to ask....although groups of three or at least two is preferable.)

Identify 5 questions you will ask.

Assess questions for open-ended, non-judgmental, clarity, logical follow-up on previous answers.

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LEGEND:

—COMMUNICATION MATERIALS
—PROJECT LEA/RN MATERIALS
—INSTRUCTOR MATERIALS