NATIONAL MUSEUM OF THE UNITED STATES AIR FORCE

Why Do We Dehydrate Space Food?

Students practice math and science skills while they learn about space food. Concepts taught include dehydration and rehydration, chemical solutions, measurements, and an introduction to Newton's Second Law of Motion.

LESSON PLAN

Introduction

Providing food for astronauts to eat during spaceflight has been a very challenging task. Food needs to be compact and light weight and provide all the nutrients the astronaut needs to remain healthy. It also needs to taste good and to feel and smell as close to food we eat here on earth as possible. The categories of space food include rehydratable, thermostabilized, intermediate moisture, natural form, irradiated, frozen, fresh and refrigerated. This lesson plan will focus on rehydratable food and will involve math, science, technology and engineering content and skills. It is assumed that the students have a prior understanding of the microgravity environment of spaceflight.

Grade Level: 6—8

National Math Standards:
Number and Operations, Measurement, Data Analysis, Problem Solving, Communication and Connections.

National Science Education Standards:
Unifying Concepts and Processes, Science as Inquiry, Physical Science, Science and Technology, and Science in Personal and Social Perspective.

Lesson Objective

In this lesson, students will discover why many space foods are dehydrated experimenting with a powdered drink mix.

Problem

What might be the important advantages to dehydrating beverages to be consumed in spaceflight? [weight and size are both reduced] How can we test this hypothesis?

Learning Objectives

The students will

- Learn why the physical size of an object and its weight are important in space travel.
- Work cooperatively in teams to complete the lesson.
- Hypothesize why many foods used in spaceflight are dehydrated.
- Decide what process to use to determine if the hypothesis is correct.
- Use measuring skills to calculate the amount and weight of powdered drink mix required for a single serving size.
- Use measuring skills to calculate the amount and weight of the reconstituted beverage.
- Compare the two results. Express the difference in mathematical terms.

Materials Required:

- Sandwich-sized re-sealable plastic bags
- Variety of powdered drink mixes, both sweetened and unsweetened
- Sugar
- Artificial sweetener
- Electronic scale
- Rulers/tape measure
- Beakers or glasses
- Measuring cups or beakers
- Measuring spoons

Resources:

- *http://spaceflight.nasa.gov/shuttle/reference/factsheets/food.html*
- *http://www.nasa.gov/pdf/71426main_FS-2002-10-079-JSC.pdf*
- *http://www.nasa.gov/audience/foreducators/topnav/materials/listbytype/Space_Food_and_Nutrition_Educator_Guide.html*
- *http://spaceflight.nasa.gov/living/spacefood/index.html*

Procedures:

- Begin by giving the students a scenario in which they are going to have to carry an object a very long distance, but they have a choice between two different objects—one that is very heavy (lots of mass) and one that is very light (very little mass). Which would they choose and why? The lighter object—the one with less mass—takes less effort to move. Explain that they have just described Newton's Second Law of Motion. The amount of force that it takes to move an object depends on the amount of mass. The more mass, the more force needed. This is a real problem for rocket engineers who need to design a rocket to carry a lot of mass into space. The less mass the better for getting an object launched through our atmosphere into space. In addition, the amount of space available in a space-ship is always a concern.
- If necessary, introduce the concept of microgravity/freefall to the students. Also, introduce the vocabulary to be used in this lesson (dehydrate, rehydrate, solution, dissolve).
- The students will work in teams of 4 to 5 students.
- Have the students hypothesize as to why some foods are dehydrated for spaceflight. They should understand that this process will create food that weighs less and also is easier to store. Have the students decide how they can test that theory—by weighing and measuring a food substance that is dehydrated and then again after reconstituting the same amount of food.
- Give the students a container of powdered drink mix and several plastic sandwich bags with pressure seal closures.
- Given the amount of powder needed to create a larger amount (e.g. a quart or a gallon), students will need to determine the correct amount of powder to use for a single serving size (8 ounces). They will then need to measure out that amount of powder.
    - For example, if it takes 1 cup of powder to make 2 quarts of beverage, then it will take 1/8 cup of powder to make an 8 ounce serving [2 quarts = 64 ounces or 8 servings]
- Students will need to then weigh the empty bag and then weigh the bag with the powder inside.
- Determine the weight of the powder by subtracting the weight of the empty bag from the weight of the bag with the powder inside. Record the weight.
- Students should weigh a second empty bag and then again add the amount of powder needed for a single serving. In this bag, the students need to add 8 ounces of water. The bag should be carefully sealed and manipulated to help dissolve the powder into a beverage. Then they should weigh the bag with the reconstituted beverage and subtract the weight of the empty bag to find the weight of the reconstituted beverage. Record the weight.
- Compare the two weights. How much more did the reconstituted beverage weigh? What percentage increase is that?
- Students should also measure the two bags to determine if one takes up more space (length and width will be the same—but take a look at the depth). What is the difference in the size of the bags? Give the exact measurements and percentage increase.
- To determine the extent of the savings in both size and weight for beverages alone, students should calculate the total savings in both the size and the weight if the requirement is to launch seven astronauts for two weeks with each having enough packets to make three servings of beverage per day.

[continued]

Special Note:

Give extra credit to students who question whether or not taking a beverage in powdered form is really easier and cheaper! Don't you have to carry the water with you, too? Then why not mix them together from the beginning? Perhaps they can research the answer to this question! Water was readily available on the Space Shuttle as it was a by-product of the fuel cells used to power the shuttle's electrical systems. On the International Space Station, however, fuel cells are not used—it is more economical and more practical to use solar arrays to convert sunlight into energy. So water does have to be taken to the station. However, they have begun an extensive system of re-cycling the water used on the station to cut back on the amount of water that needs to be taken and stored there. Also, dehydrated food has the extra advantage of easier storage.

Additions or Extensions:

- Have students try different types of food—pudding, for example. Compare the savings in size and weight for the dehydrated powder and for the reconstituted pudding.
- Have the students use a beverage powder that requires the addition of sugar or a sugar substitute. Have some students use cane sugar and others add an artificial sweetener. Did the baggies with the dry powder weigh the same or were they different? Did the reconstituted beverages weigh the same or were they different? Based on this information alone, which is better for space travel: regular sugar or a sugar substitute? Why?
- Students could research how an astronaut would drink the reconstituted beverage from a bag (astronauts have special beverage bags that contain built-in straws with clips—why?). How do liquids react in microgravity?
- Have students research the process of dehydration, especially how the powdered drink mixes are made. Perhaps they could dehydrate some fruit for a classroom snack.
- Include a lesson on the chemistry of the mixture created when the water was added to the powder. What type of mixture is it (emulsion, suspension, solution, etc.)? Why?