

Activity 7:

How Much Is Waste?

Objective

Measure the mass and volume of a food package before and after repackaging for space flight, and determine the usable and waste portions of food selected for space flight.

Science Standards

- **Science as Inquiry:** Abilities necessary to do scientific inquiry.
- **Physical Science:** Properties and changes of properties of matter.

Mathematics Standard

- **Computation**
- **Measurement**

Materials Needed

Commercial food box such as a cereal box
Unshelled nuts: almond, cashew, macadamia, peanut
Fresh fruits: apple, grapefruit, lemon, orange
Metric balance
Weights
Plastic zip-locking snack and sandwich bags
Metric rulers
Calculators
Student Data Sheets

Background

The original design of the space food packaging for Projects Mercury, Gemini, and Apollo was light in weight and easily handled in microgravity, and it required minimum storage space. These specifications fit the prime life support design requirements for all spacecraft systems: minimum weight and volume, minimum power usage, reliability, ease of maintenance, environmental compatibility, integration with other systems, and crew compatibility.

As spacecraft design improved, allowing for longer flight durations and larger crew and cargo capabilities, the food manifest greatly improved. For instance, the Space Shuttle and ISS food lists contain nuts, shelled to reduce waste and mess. In addition, the lists also contain fruits and fruit juices. These fruits may be whole or presliced to reduce waste and mess.

Because of the increasing problem of orbital debris, the only substance dumped on orbit into space is excess water, a byproduct of electrical power generated from the Space Shuttle fuel cells. Onboard waste containment is a concern for space flight. A trash compactor is on the Space Shuttle and is also planned for the ISS to reduce the bulk of waste products.

Procedure

Part 1. Minimize the Mass of a Grocery Store Package

1. Weigh the package.
2. Calculate the mass and volume of the food package.
3. Open the package, remove the contents, and place them in a plastic zip-locking sandwich bag, removing as much air from the package as possible.
4. Weigh the new package.
5. Determine the volume of the new package.
6. Calculate the percentage of mass loss.
7. Calculate the percentage of volume loss.

Part 2. Determine the Usable and Waste Portions of 10 Nuts

Note: Use 10 nuts, and divide by 10 to come up with the amount for 1 nut.

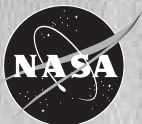
1. Weigh 10 nuts.
2. Shell the nuts, and weigh the edible portion.
3. Collect the shells, and weigh the nut shells.
4. Calculate the percentage that is edible.
5. Calculate the percentage of waste.

Part 3. Determine the Edible and Waste Portions of a Fruit

1. Weigh the fruit.
2. Peel and core the fruit.
3. Weigh the edible portion of the fruit.
4. Weigh the peel and core of the fruit.
5. Calculate the percentage that is edible.
6. Calculate the percentage that is waste.

Discussion

1. Did the packaging make that much of a difference in weight? In volume?
2. After removing the parts of food that would not be eaten, did the weight decrease significantly?
3. Which food product lost the most weight? Was it because of packaging or waste portions of the food?



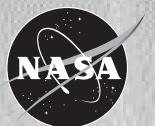
Extensions

1. Have the students find other types of food that contain waste portions.
2. Fruit juices are manifested for the ISS. Extract juice from selected fruit(s) and calculate the amount of juice available:

$$\% \text{ juice} = \text{liquid mass} / \text{total mass} \times 100$$

Assessment

Collect the completed Student Data Sheets, and determine whether the mathematical computations are correct. Through classroom discussion, determine usable and unusable portions of foods.



Student Data Sheet

Name

PART 1. MINIMIZE THE MASS OF A GROCERY STORE PACKAGE

Calculate the percentage of mass loss:

$$\% \text{ Package Mass Loss} = \frac{\text{store pack mass} - \text{space pack mass}}{\text{store pack mass}} \times 100$$

Calculate the percentage of volume loss:

$$\% \text{ Package Volume Loss} = \frac{\text{store pack volume} - \text{space pack volume}}{\text{store pack volume}} \times 100$$

PART 2. DETERMINE THE USABLE AND WASTE PORTIONS OF 10 NUTS

Calculate the percentage of the edible portion:

$$\% \text{ Edible} = \frac{\text{edible mass}}{\text{total mass}} \times 100$$

Calculate the percentage of the waste portion:

$$\% \text{ Waste} = \frac{\text{shell mass}}{\text{total mass}} \times 100$$

PART 3. DETERMINE THE EDIBLE AND WASTE PORTIONS OF A FRESH FRUIT

Calculate the percentage of the edible portion of the fresh fruit:

$$\% \text{ Edible} = \frac{\text{edible mass}}{\text{total mass}} \times 100$$

Calculate the percentage of the waste portion of the fresh fruit:

$$\% \text{ Waste} = \frac{\text{peel} + \text{core mass}}{\text{total mass}} \times 100$$

