Measuring Water Vapor Lost Through the Dehydration of Fruits and Vegetables

Lesson By Service Member Daniel Marbury, Michigan

Theme:
States of Matter
Metric Measurement
Food Safety and Storage
Percentages

Grade Level: 4-5

Subject Area: Science, Math

Summary:

In this lesson, students will conduct an experiment to calculate the percentage of a fruit or vegetable that is lost from water vapor, which escapes during a cooking process.

Michigan GLCEs:
S.IP.04.11 Make purposeful observation of the natural world using the appropriate senses.
S.IP.04.12 Generate questions based on observations.
S.IP.04.13 Plan and conduct simple and fair investigations.
S.IP.04.14 Manipulate simple tools that aid observation and data collection.
S.IP.04.15 Make accurate measurements with appropriate units for the measurement tool.
S.IP.04.16 Construct simple charts and graphs from data and observations.
P.PM.04.16 Measure the weight (spring scale) and mass (balances in grams or kilograms) of objects.
P.PM.04.23 Compare and contrast the states (solids, liquids, gases) of matter.

Preparation:
Prep Time: 15 min

1. Make copies of the experiment sheet for all your students.
2. Before the day of the experiment select 1-6 different fruits and vegetables as a class, which are currently in season and available for purchase from local farms.
   (*Optional: You may prepare foods for dehydration before working with students. This will take about 15 minutes per food being used and will save about 15-30 minutes of class time preparing foods with students. However, preparing foods too far in advance will result in water loss prior to the experiment and will affect the results.)*

Teaching Time: 1hr
Cooking Time: In Oven 20-40 minutes; In Dehydrator 4-6 hours

Materials:

- Experiment worksheet

- Selection of seasonal fruits and vegetables (at least 100 grams each, but better yet, enough slices for everyone in class to sample). *Good examples include: apples, peaches, beets, potatoes, parsnips, and carrots.*
- Knives & cutting board
- Food dehydrator OR baking pan and oven
- Digital, spring, or balance scale with metric units

Opening:

1. Discuss or review the states of matter and ask students to consider why cooking foods will make them lighter. Explain the conversion of water inside fruits and vegetables to water vapor at room temperature and at increased rates with the application of heat.
2. Discuss the seasonal availability of the foods you are using for the experiment. Discuss different methods for storing food, including dehydration as one of the earliest forms of food storage. Explain the acronym FAT TOM to teach the essential components that bacteria need to grow. Clarify that by dehydrating food and removing the essential need of moisture for bacterial growth, we reduce the risk of spoiling and contamination from bacteria.
    - Food – Your food is food for bacteria too
    - Acid – Most bacteria thrive in an environment that is not too acidic and not to alkaline
    - Time – Bacteria multiply exponentially over time
    - Temperature – Most pathogenic bacteria grow on food in the "temperature danger zone" between 41 degrees and 135 degrees Fahrenheit
    - Oxygen – Different bacteria grow whether oxygen is present or absent (botulism for example grows in an anaerobic environment)
    - Moisture – Water is necessary for the growth of bacteria

Lesson Procedure:

Part 1. Prepare and Weigh Foods (20-30min)

1. Have all students wash hands and clean desk spaces.
2. Divide students into groups of four to five students. Divide foods among students and have groups wash all foods and dry them completely with clean paper towels.
3. With the attention of the entire class demonstrate the proper use of knives or other kitchen tools (corers, peelers, etc.) that will be used to the remove parts of the foods, which are not good to eat, including stems, seeds, skin and tough tips.
4. With the attention of the entire class demonstrate cutting foods into very thin flat shapes such as circles (for carrots), triangles (for apples), or rings (apples).
5. Collect all of the pieces of each food at the front of the class and weigh them together using a scale or balance. Be sure to explain the subtraction of the weight of the bowl used to hold the food.
6. Instruct students to record the measurements in the second row of the measurement table on their worksheet.
7. Put your foods into a dehydrator or oven. You may have to dehydrate items one at a time, depending on the space available on the racks. Just make sure that you dehydrate all of the pieces of a particular food together.

Part 2. Weigh, Graph and Taste Foods (20-30min)

1. Note and have students record the amount of time you leave the food in the dehydrator/oven. Afterward the duration you decide (in a dehydrator at least 4-6 hours, in a oven 20-40 min at 375 degrees Fahrenheit), weigh the dehydrated foods and record in the table above in the third row labeled dehydrated weight.
2. Calculate the percentage of each fruit and vegetable that is water using the following steps. First, subtract the dehydrated weight from the initial weight. Second, divide this difference by the initial weight of the food. Last, multiply this number by 100.
3. As a class make a graph to compare the water content of the fruits and veggies from your experiment.

Wrap up:

With most fruits and vegetables you will observe at least a 70% reduction in weight due to water loss during your experiment even without removing every bit of water. Use your results as an opportunity to address the nutritional benefits of whole foods. Whereas whole foods give you a feeling of fullness in part due to the water that they contain, processed foods that have no water pack more calories in a smaller space and don't necessarily make you feel full. Even if you didn't dehydrate a potato in your experiment, you might discuss the transformation from a potato to chip as an example. One baked potato might fill you up for a small meal, whereas the 20 – 30 chips it might produce would weigh far less and probably wouldn't fill you up while delivering the same amount of energy and more from oils used in the frying process, all of which will have to be used by your body through immediate exercise, or will become stored as fat.

Name _____

Measuring Water Lost Through the Dehydration of Fruits and Vegetables

Experimental Procedure:

1. Wash your hands and clean your desk space.
2. Wash all foods and dry them completely.
3. As a class or with your group, follow your teacher's demonstration and instructions to use kitchen tools to remove parts of the foods, which are not good to eat. (This might include stems, seeds, skin and tough tips).
4. As a class or with your group, follow your teacher's demonstration and instructions, cut foods into very thin flat shapes such as circles (for carrots) or triangles (for apples), or rings (apples).
5. Collect all of the pieces of each food and weigh them together using a scale or balance. (Be sure to subtract the weight of the bowl they are in.)
6. Record your measurements in the second row of the following table labeled 'Initial Weight.'

Table: Measuring Dehydration of Fruits and Vegetables

	Foods					
Initial Weight						
Dehydrated Weight						
Difference (Initial – Dehydrated)						
Percent Water						
(Time In Heat Source)						

Experimental Procedure:

1. Put your foods into a dehydrator or oven. You may have to dehydrate items one at a time, depending on the space available on the racks. Just make sure that you dehydrate all of the pieces of a particular food together.
2. Note the amount of time you leave the food in the dehydrator/oven. Afterwards, weigh the dehydrated foods and record in the table above in the third row labeled 'Dehydrated Weight.'
3. Calculate the Difference by subtracting the Dehydrated from the Initial Weight.
4. Calculate the percentage of each fruit and vegetable that is water using the following steps: First, divide the Difference by the Initial Weight of the food. Last, multiply this number by 100
5. As a class make a graph to compare the water content of the fruits and veggies from your experiment.