TO POP OR NOT TO POP…THAT IS THE QUESTION.

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Annotation

In this laboratory exercise, students will demonstrate science process skills as they use moisture content measurements to explain why popcorn pops.

Primary Learning Outcomes:

Students will be able to calculate moisture content of popcorn kernels and use this data to determine and explain the phenomenon of popped corn.

Students will be able to identify popping corn as a physical change.

Students will be able to communicate data among groups, calculate mean values, and demonstrate the importance of replication and precision in experimental design.

Georgia Performance Standards:

Characteristics of Science

SCSh2. Students will use standard safety practices for all classroom laboratory and field investigations.

SCSh3. Students will identify and investigate problems scientifically.

SCSh4. Students use tools and instruments for observing, measuring, and manipulating scientific equipment and materials.

SCSh5. Students will demonstrate the computation and estimation skills necessary for analyzing data and developing reasonable scientific explanations.

SCSh8. Students will understand important features of the process of scientific inquiry.

Chemistry Content

SC6. Students will understand the effects motion of atoms and molecules in chemical and physical processes.

Duration:

Preparation: 30 minutes (kernels must be dried and soaked overnight)
Introduction: 10 minutes
Lab Exercise: 25 minutes
Discussion/Demonstration: 25 minutes
Total Class Time: 60 minutes

Materials and Equipment:

For Teacher Preparation and Demonstration:

1. Oven
2. Baking sheet
3. Large beaker for soaking kernels
4. Popcorn kernels
5. Vegetable oil
6. 2 250-mL Erlenmeyer flasks
7. Aluminum foil
8. 50-mL graduated cylinder
9. Tongs
10. Hot plate
11. Safety goggles
12. Aprons
13. Heat-resistant gloves (optional)

Per Class:

1. Electronic balance(s)

Per Group:

1. 250-mL Erlenmeyer flasks
2. 20-kernel popcorn sample
3. Vegetable oil
4. Aluminum foil
5. 50-mL graduated cylinder
6. Tongs
7. Hot plate
8. Safety goggles
9. Aprons
10. Heat-resistant gloves (optional)

Safety:

The primary safety concern in this laboratory exercise is the heat produced during popping of the corn. Ensure that students use caution when handling hot objects. Furthermore, ensure that students properly cover flasks with aluminum foil to prevent hot oil spattering.

Technology Connection:

Not applicable.

Procedures:

Teacher Preparation:

Drying kernels:

- Preheat oven to 190^{o}F
- Spread 1 cup of popcorn kernels in a single layer on baking sheet

- Dry Kernels overnight

Soaking kernels:

- Pour 1 cup of popcorn kernels into a large beaker
- Cover kernels with water
- Soak kernels overnight
- After soaking, place kernels on paper towels and allow to dry for approximately 1 hour (this allows the hull of the kernel to dry but the kernel itself will maintain its increased moisture content)

Control kernels:

- Measure one cup of untreated kernels for control samples

Estimated Time:
30 minutes

Introduction:
Present a brief introduction and history of popcorn (see below), without disclosing the science involved (bolded below).

Popcorn is a popular food item that was first introduced to European settlers by American Indians. The popcorn kernel is comprised primarily of sugars, starches, and water. Much of this water is lost during the popping process, resulting in popped corn. **As the kernel is heated, water within the kernel boils, forming steam. Because the steam occupies a much greater volume than did the water, pressure within the kernel builds, causing the kernel to explode and the steam to escape. As the kernel explodes and turns itself inside out, the escaping steam "puffs up" the starches within the kernel, increasing its volume.** It is this "popped" corn that Americans have continued to enjoy for centuries.
Poll students on why they believe that popcorn pops and whether this is a physical or chemical change. Explain to students that the following exercise will demonstrate the phenomenon of popping corn and how we know that water plays such an important role in popping corn. Lastly, review the basic laboratory procedure as presented in the attached student handout.

Estimated Time:
10 minutes

Lab Exercise:
Students should follow procedures outlined in the attached student handout.

Estimated Time:
25 minutes.

Discussion/Demonstration:
Students should complete Part One of the Discussion Questions found on the student handout. Following student completion of the questions, conduct a class discussion, having students share their hypotheses as to why popcorn pops and whether or not the process is a physical or chemical

change. It is hoped students will attribute popping of the corn to the loss of water, as steam. Therefore, to further demonstrate the importance of water, perform for the students the following demonstration.

Using the procedure found in the student handout, attempt to pop the dried kernels. As the kernels are popping, explain to students the process in which they were dried. In much the same manner, attempt to pop the soaked kernels. Again, as the kernels are popping, explain to students the process in which they were soaked.

Following completion of the demonstration, have students answer Part Two of the Discussion Questions. As a result of the demonstration and further class discussion, students should discover that the kernel moisture content is directly related to popping ability. Ideally, popcorn kernels should have a moisture content of approximately 13%. When kernels reach a temperature of approximately 400 ^{o}F (200 ^{o}C), moisture in the kernel vaporizes with pressure sufficient to explode the kernel and form popped corn. Dried kernels lose moisture during the drying process, and therefore, cannot build up enough steam to explode the kernel. Soaked kernels gain moisture during the soaking process, damaging the integrity of the kernel, and therefore, allowing steam to escape. The gradual escape of steam, rather than the explosion caused when pressure builds, prevents the kernel from popping.

Estimated Time:
25 minutes

Assessment:
Students should be assessed based on completion of the student handout.

TO POP OR NOT TO POP…THAT IS THE QUESTION *Student Handout*

Did you know?

- Popcorn was an important food to Native Americans and was served at the first Thanksgiving.
- Popcorn is sold in 99% of all movie theaters.
- Residents of Minneapolis and St. Paul (Minnesota) eat more popcorn per person than do people anywhere else in the US.
- Archaeologists have found popcorn that is more than 1,000 years old.

Purpose:

To calculate the moisture content of popcorn kernels and to explain, using the concept of moisture content, why popcorn pops.

Materials:

1. Balance
2. 250-mL Erlenmeyer flask
3. 20-kernel popcorn sample
4. vegetable oil
5. aluminum foil
6. 50-mL graduated cylinder
7. tongs
8. hot plate
9. safety goggles
10. aprons
11. heat-resistant gloves (optional)

Procedure:

1. Obtain 20 popcorn kernels from the teacher.
2. Into a clean, dry 250-mL Erlenmeyer flask, pour 10 mL vegetable oil.
3. Determine the mass of the flask and vegetable oil and record in Data section below.
4. Place the popcorn kernels into the Erlenmeyer flask. Determine the mass of the flask, vegetable oil, and unpopped kernels, and record in Data section below.
5. Using aluminum foil, make a cover for the flask. Squeeze the cover tightly around the top of the flask. With a pencil, poke two small holes in the foil.
6. Heat the flask on the hot plate, moving it around to ensure that the kernels do not burn. Once the kernels have stopped popping, remove the flask from the heat. Carefully remove the foil cover to allow the steam to escape.
7. Once the flask has cooled, determine the mass of the flask, oil, and popped kernels after popping, and record in Data section below.
8. Determine the number of popped and unpopped control kernels, and record in Data section below.

Data:

Mass of Flask + Vegetable Oil _____ g

Mass of Flask + Vegetable Oil + Kernels Before Popping _____ g

Mass of Flask + Vegetable Oil + Kernels After Popping _____ g

Popped Kernels After Popping _____

Unpopped Kernels After Popping _____

Calculations (*Please show ALL work)***:**

1. Calculate the mass of the kernels before popping.

2. Calculate the mass of the kernels after popping.

3. Calculate the change in mass that resulted from popping the kernels.

4. Calculate the percent kernel moisture using the following equation:

$$\% \text{ kernel moisture} = \frac{\text{mass of water lost}}{\text{mass of unpopped kernels}} \times 100$$

5. Calculate the percent kernels popped.

6. Obtain the moisture content results of two other groups. Record all values below and calculate the average.

Discussion Questions:

Part One *(To be answered following completion of the laboratory exercise)*:

1. Describe any changes (mass, volume, appearance, # popped and unpopped kernels, etc.) observed in the kernels as a result of popping.
2. You should have found that the mass of the popped kernels was less than that of the unpopped kernels. How do you explain this change in mass?
3. Based on your observations and the data you collected, develop a hypothesis explaining why popcorn pops.
4. Is the popping of corn a physical or chemical change? Explain your answer.

Part Two *(To be answered following demonstration and class discussion)*:

1. What did you observe as the dried kernels were popped? How did this compare to the kernels you popped?
2. What did you observe as the soaked kernels were popped? How did this compare to the kernels you popped?
3. Based on these observations, has your hypothesis changed? If so, how?
4. Is the popping of corn a physical or chemical change? Explain your answer.

Extension Questions:

1. How might kernels lose moisture? Gain moisture?
2. Must dried kernels be thrown away? If not, how might they be rehydrated?
3. How might the popping ability of a kernel be affected if its outer shell was punctured? Why?