POPCORN

According to The Popcorn Board, Americans today consume 17 billion quarts of popped popcorn each year. The average American eats about 54 quarts. Think about that next time you sit down to a movie with that big bowl or box of popcorn.

No one knows the exact origin of popcorn, but the oldest ears of popcorn ever found were discovered in a Bat Cave of west central New Mexico in 1948 and 1950. Different reports put the range of age of the popcorn to over 4,000 to over 5,600 years old. Archaeologists believe that popcorn originated in Mexico, but they know that it was grown in China, Sumatra, and India. By the time Columbus arrived in American in 1492, popcorn was widespread throughout North and South America and was enjoyed by most Native American tribes.

Popcorn grains found in the tombs on the east coast of Peru that were a 1,000 years old – and they were so well preserved, they still popped. Popcorn was an integral part to early 16th century Aztec Indian ceremonies, and, in 1519, Cortes got his first sight of popcorn when he invaded Mexico.

Popcorn was introduced to the English colonists at the first Thanksgiving Feast at Plymouth, Massachusetts.

From the 1890s until the Great Depression, street vendors used to follow crowds around, pushing steam or gas-powered poppers through fairs, parks and expositions

When television became popular in the early 1950s, attendance at movie theatres dropped and so did popcorn consumption. New products and marketing (See Figure 1) made eating popcorn at home more convenient and resulted in a resurge in popularity. Today, microwave popcorn has accounted for over $240 million in annual U.S. popcorn sales.

Figure 1. Jiffy pop popcorn. A self-contained home popcorn maker. When heated on a range, the package inflates as the popcorn pops.

Materials Needed

popping corn
Oil: vegetable oil, corn oil, or peanut oil.
Store unused popcorn in a sealed plastic bag or a jar.
Erlenmeyer flask, 250 mL
graduated cylinders, 100-mL, 250-mL
metal tack (such as an upholstery or carpet tack) or small knife
Bunsen burner
test tube holder
ring stand with ring, or a tripod, and wire gauze, or a pair of flask tongs

Safety

Safety glasses or goggles must be worn in the laboratory at all times.

If this experiment is performed in a chemistry laboratory, all work surfaces must be cleaned and free from laboratory chemicals. After cleaning work surfaces, it is advised to cover all work areas with aluminum foil or a food-grade paper covering.

All glassware and apparatus must be clean and free from laboratory chemicals. Use only special glassware and equipment, stored away from all sources of laboratory chemical contamination, and reserved only for food experiments is recommended.

There are no safety hazards associated with the materials used in this experiment.

Disposal

Generally, all waste materials in this experiment can be disposed in the trash or poured down the drain with running water. All disposal must conform to local regulations.

Procedure

Advance preparation

Take approximately 1/4 cup of popcorn, place it in single layer in a small aluminum foil pan and place it in an oven at 88º to 93ºC (190º to 200ºF) for about two hours. Store this popcorn in a labeled, sealed plastic bag or a jar. Use within 24 hours.

Take approximately 1/4 cup of popcorn, place it in a beaker or a small aluminum foil pan, add water to barely cover it, and allow the kernels to soak for about two hours. Dry the kernels with a paper towel and store in a labeled, sealed plastic bag or a jar. Use within 24 hours.

Investigating why does popcorn pop?

Obtain a 250-mL Erlenmeyer flask. Make a cover for the flask using a small square of aluminum foil. Poke 3 or 4 small holes in the top of the aluminum foil with a pin or tack. Weigh the flask and cover.

Add 5 mL (1 tsp.) of cooking oil to the flask. Weigh the oil, flask, and cover.
Place 20 kernels of popcorn in a 100-mL or 250-mL graduated cylinder. Record the approximate volume of the kernels.

Carefully remove the cover from the flask and add the 20 kernels of popcorn to the flask. Weigh the flask, cover, oil, and popcorn. Determine the mass of the popcorn kernels.

Heat the flask by placing it on a ring support on a ring stand or a tripod and then, holding a Bunsen burner in your hand, keep moving the flame around to heat the kernels trying not to burn them. (As an alternative, heating can be done on a hot plate. Hold the flask

with flask tongs and keep the flask moving around to prevent burning the kernels.) As the popcorn starts to pop, remove the flask from the heat and then heat only gently to pop the remaining kernels. Take care not to burn the popcorn. What do you observe inside the flask as the kernels are popping?

After all the kernels have popped, gently heat the upper part of the flask to remove any moisture. Take care not to burn the kernels.

Allow the flask to cool to room temperature. Weigh the flask, lid and contents. Determine the mass of the popcorn. How do you explain the difference in mass?

Transfer the popped corn to the 250-mL graduated cylinder. Record the approximate volume and appearance of the popped corn.

Repeat the process with another 20 kernels of popcorn or compare the results with other groups in the class.

Investigating factors affecting the popping of popcorn

Add the 20 kernels of pre-dried popcorn to the 250-mL flask. Cover the flask with the aluminum foil cover and heat the flask, in the same manner as in Part 1, above, until the kernels have popped.

After all the kernels have popped, gently heat the upper part of the flask to remove any moisture. Take care not to burn the kernels.

Allow the flask to cool to room temperature. Transfer the popped corn to the 250-mL graduated cylinder. Record the approximate volume and note the appearance of the popped corn.

Repeat this procedure using 20 kernels of the water-soaked popcorn.

Obtain 20 kernels of popcorn. Using a metal tack or a knife, poke 2 or 3 small holes in the outer hull of each kernel. Place the kernels in the 250-mL flask and repeat the popping procedure, above.

How does the appearance and the volume of the three types of popcorn compare? What factors affect the popping of the popcorn?

Based on your observations in this experiment, can you explain why popcorn pops?

Explanation

There is no detailed explanation of why popcorn pops. What follows is the accepted explanation.

The starch grains are embedded in a protein matrix, which, in popcorn, is stronger than other grains because it has a higher protein to starch ratio. When the kernel is heated to about 66ºC (150ºF), the moisture it contains partly gelatinizes the starch grains. As the

temperature reaches the boiling point of water, the water vaporizes and expands rapidly in volume. The hard protein matrix holds until the pressure becomes too great, at which point the kernel bursts open and the endosperm expands in volume due to the pressure difference. The water evaporates and the cooked starch granules are dried out making the endosperm light and crisp. If the moisture cannot escape, it get reabsorbed by the popped corn making it chewy and tough.

Popcorn pops best when it has a moisture content of 11 to 14%.

Natural rice grains, in their hulls can also be popped.

Cereals such as puffed rice and puffed wheat are heated in a pressure cooker to keep the kernels filled with superheated water. When the pressure is released quickly, the kernels puff in the same way the popcorn pops.

References

Sarquis, Mickey and Jerry, *Fun With Chemistry*, Volume 1, Institute for Chemical Education, University of Wisconsin-Madison, 1991.

McGee, Harold, *On Food and Cooking*, Charles Scribner's Sons, New York, NY, 1984.

Coultate, Tom and Jill Davies, *Food, The Definitive Guide*, Royal Society of Chemistry, Cambridge, UK, 1994.

POPCORN
DATA and RESULTS

Name(s) _____ Course _____

Date _____

Investigating why does popcorn pop?

	Trial 1	Trial 2
Mass of flask and cover	_____ g	_____ g
Mass of oil, flask, and cover	_____ g	_____ g
Mass of oil used	_____ g	_____ g
Volume of popcorn kernels	_____ g	_____ g
Mass of flask, cover, oil, and popcorn	_____ g	_____ g
Mass of popcorn	_____ g	_____ g

What do you observe inside the flask as the kernels are popping?

Mass of flask, cover, oil, and popped popcorn	_____ g	_____ g
Mass of popped popcorn	_____ g	_____ g

How do you explain the difference in mass?

Volume of popped popcorn kernels	_____ g	_____ g

How do your results compare between the two trials and with other groups in the class?

Investigating factors affecting the popping of popcorn

	Pre-dried popcorn	**Water soaked** popcorn	**Popcorn with** puncture holes
Mass of flask and cover	_____ g	_____g	_____ g
Mass of oil, flask, and cover	_____ g	_____g	_____ g
Mass of oil used	_____ g	_____g	_____ g
Volume of popcorn kernels	_____ g	_____g	_____ g
Mass of flask, cover, oil, and popcorn	_____ g	_____g	_____ g
Mass of popcorn	_____ g	_____g	_____ g
Mass of flask, cover, oil, and popped popcorn	_____ g	_____g	_____ g
Mass of popped popcorn	_____ g	_____g	_____ g
Volume of popped popcorn kernels	_____ g	_____g	_____ g

How does the appearance and the volume of the three types of popcorn compare?

What factors affect the popping of the popcorn?

Based on your observations in this experiment, can you explain why popcorn pops?