Ice Cream in a Bag Experiments

Grade Level: 4-8

Lesson Overview

I scream, you scream, we all scream for ice cream, but did you know that the fat content of the dairy ingredients can change the flavor? Use this favorite treat to engage students in science inquiry.

Student Objectives

1. Compare and contrast homemade ice cream with various fat contents.
2. Explain the use of salt in ice cream making.

Materials

- ✓ 6 one gallon Ziplock freezer bags
- ✓ 6 one quart Ziplock freezer bags
- ✓ 1½ cups of sugar
- ✓ 3 teaspoons of vanilla extract
- ✓ 2 cups of skim milk
- ✓ 2 cups of 2% milk
- ✓ 2 cups of whole milk
- ✓ 3 cups of half and half
- ✓ 3 cups of heavy cream
- ✓ ice - enough to fill all 6 gallon bags half full
- ✓ 6 towels (to wrap around the bags)
- ✓ 6 cups of rock salt
- ✓ measuring cups
- ✓ measuring spoons
- ✓ duct tape
- ✓ scissors
- ✓ 180 3-ounce plastic cups
- ✓ 30 spoons
- ✓ worksheets for each student:
  - Ice Cream Initial Survey
  - Ice Cream Taste Test Survey
  - The Science of Why it Freezes

Background Information

Ice cream is a valuable dairy product. It is an excellent source of protein, vitamins, and calcium. The primary ingredients for ice cream are ilk solids, milk fat, cream, sweetener, flavoring, and stabilizing materials. Air is mixed with the ingredients upon freezing to give ice cream its smooth, light texture. Ice cream freezes at -6° C (21° F). Ice cream can be made in the classroom with the understanding that the freezing point of water is lowered by adding salt to the ice to be used between the plastic bags. Heat energy is transferred easily from the milk through the plastic bag to the salty ice water causing the ice cream mixture to freeze and the ice to melt.

Procedure

Compare and contrast homemade ice cream with various fat contents

1. In this activity, students will make ice cream in a bag. Different combinations of milk and cream will be used to vary the fat content of the ice cream. Divide the class into 6 groups. If more than 30 students are participating, simply make more bags of each combination in order to accommodate the size of the group.

   Caution: Students who are allergic to milk or milk products should not taste the ice cream

   For best results, this should be a blind experiment in that students do not know which combination they are tasting. The teacher may choose to put the ingredients in the small Ziplock bags in advance and label them with letters.

   Then store them in a refrigerator until ready to use.

2. Ask students to fill out the initial survey. Then, collect the completed surveys.

3. In the quart Ziplock freezer bag, place 1/4 cup of sugar, ½ teaspoon of vanilla extract, 1 cup of milk and 1 cup of cream. Below is an example of how the samples may be set up. Be sure to seal the bag well. Then use a piece of duct tape to seal the Ziplock end of the bag.

   Label each bag with a letter.

   Sample A: skim milk & half and half.
   Sample B: whole milk & heavy cream.
   Sample C: 2% milk & half and half.
   Sample D: skim milk & heavy cream.
   Sample E: whole milk & half and half.
   Sample F: 2% milk and heavy cream.

4. Fill the gallon Ziplock freezer bag half full of ice. Add one cup of rock salt.

5. Place the quart size bag with the ice cream ingredients into the gallon Ziplock bag of ice and rock salt. Be sure to seal the bag well. Then use a piece of duct

tape to seal the Ziplock end of the bag. Label each bag with the appropriate sample letter.

6. Wrap the gallon bag in a towel. Have each group of students take turns shaking their bag until the ice cream is frozen. Remind the students to be careful not to drop the bag or do anything to puncture the bag. The towel will keep the students' hands from getting too cold and keep the ice from melting too fast. It will also help soak up any moisture.

   Periodically check to see if the ice cream is frozen. You may want to stop when it is the consistency of soft serve ice cream to make it easier to serve. Otherwise, it will get very hard. (This will take approximately 10 minutes depending on how well the students shake.)

7. While the students are shaking, someone should label 6 different stations with each sample letter. Set out 30 cups at each station. Pass out the taste test surveys and a spoon to each student.

8. When the ice cream is frozen, cut open the gallon Ziplock bag and remove the quart Ziplock bag. Discard the ice, salt and saltwater. Wipe off the small bag with the towel to remove the saltwater. Then, cut one corner of the bag off and squeeze the sample into the cups at the appropriate station. Each cup will contain a small amount for tasting. Repeat this process until all samples are served.

9. Students should taste one sample at a time and fill in the appropriate items on the taste test survey worksheet. The samples can be tasted in any order. When students have tasted all 6 samples, they can fill out the last part of the Ice Cream Initial Survey and Ice Cream Taste Test Survey and rank their favorite to their least favorite sample. Collect the surveys.

   At this point, there are a couple options of things to do with the surveys. One option is to ask students a few questions about their surveys. Which sample did they like the best? Which sample did they like the least? Which combination did they think they would like the best? Which combination did they think they would like the least?

   Then share the chart showing the ice cream experiment samples and fat content. Discuss.

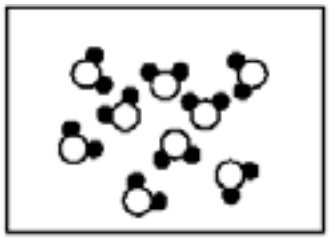
   Another option is to take this one step further and have the students compile and analyze the results of the surveys. This would make a great math activity.

Explain the importance of salt in ice cream making.

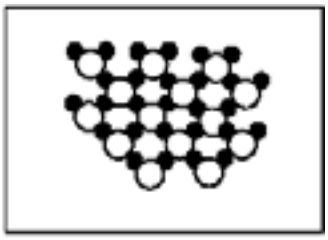
10. Use the Molecular Composition of Water page to help illustrate this point.

a. As the temperature of water changes, the molecular motion also changes. When the temperature and motion decreases, the water molecules move closer together until they fall into a regular repeating pattern.

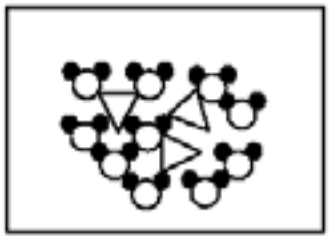
b. Temperature is a measure of molecular motion. Plain water freezes at 0°C or 32°F.

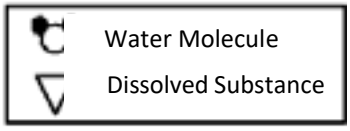


Liquid Water



Solid Water (ice)





Symbol Key

c. Substances dissolved in liquid water interfere with the formation of a regular repeating pattern when water is cooled to form ice. Liquid water, containing dissolved substances, must be cooled to a lower temperature than plain water in order to freeze.

d. In the ice cream experiment, students freeze a milk-based mixture. The mixture is composed of dissolved substances and other substances suspended in water. These substances cause the freezing point to drop below 0°C (32°F). Ice cream freezes at –6°C (21°F). The freezing point of water is lowered by adding salt.

e. Heat energy is transferred easily from the milk through the plastic bag to the salty ice water causing the ice cream mixture to freeze and the ice to melt.

Have students complete the Science of Why It Freezes worksheet**.**

Extension Activities

1. Set up a demonstration to illustrate the effect of salt on the ice. Materials needed for the activity include: 3 cups, ice, water, table salt, rock salt and 3 thermometers. Label the cups – no salt, table salt, rock salt. Fill each cup with

ice. Then cover the ice with water. Place a thermometer in each cup and record the temperatures. Then place one tablespoon of table salt in the appropriately labeled cup and one tablespoon of rock salt in the other. Record the temperatures at regular intervals such as 5 minutes, 10 minutes . . . up to at least 30 minutes. This demonstration will show that rock salt lowers the temperature more and faster than table salt.

2. The basic ice cream in a bag recipe and method could be used to set up an experiment in which the salt is the variable. One bag would use rock salt, another table salt, and another no salt.

   Another option would be to place the small Ziplock bag into a 3-pound coffee can. Add the ice and salt, have the students roll the can back and forth until the mixture freezes.

Additional Resources

- The History of Ice Cream https://www.youtube.com/watch?v=ibUlE3lYN1A
- Modern Marvels How Ice Cream is Made https://www.youtube.com/watch?v=prlBXBS_vPg
- ice cream https://www.stldairycouncil.org/uploads/FamilyResources/IceCream.pdf
- Illinois Agriculture in the Classroom Dairy Ag Mag: http://www.agintheclassroom.org/TeacherResources/AgMags.shtml
- Illinois Agriculture in the Classroom Dairy Reader http://www.agintheclassroom.org/TeacherResources/terra_nova.shtml
- St. Louis Dairy Council Ice Cream Fact Sheet https://www.stldairycouncil.org/uploads/FamilyResources/IceCream.pdf

Standards

Illinois Science Standard

MS-PS1-4. Develop a model that predicts and describes changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed.

Illinois English Language Arts Standard

RST 4: Determine the meaning of symbols, key terms, and other domain specific words and phrases as they are used in a specific scientific or technical context relevant to grades 6 – 8 texts and topics.

The **M**ultidisciplinary **AG**ricultural **I**ntegrated **C**urriculum (mAGic) was created in 2004 under the leadership of the Illinois State Board of Education (ISBE) and the Facilitating Coordination in Agricultural Education Project (FCAE). Funding was made available through the FCAE grant budget from the agricultural education line item of the ISBE budget. This revision, as printed, was developed in September 2021.

These mAGic lessons are designed to bring agriculture to life in your classroom. They address the Illinois Learning Standards in math, science, English language arts and social studies.

Dairy mAGic project update writers/reviewers: Rhodora Collins – Dekalb County; Suzi Myers – Kane County; Connie Niemann – Montgomery County; Debbie Ruff – Livingston County; Jennifer Waters – Sangamon County; and Dawn Weinberg – Hancock County.

Name _____

Ice Cream in a Bag Initial Survey

We will be making six different bags of homemade ice cream using different combinations of skim milk, 2% milk, whole milk, half and half, and heavy cream to find out if the fat content of the ice cream affects the flavor, texture, color, and creaminess of the ice cream.

Will the fat content of the ice cream affect the flavor?

_____Yes _____No

Why or why not?

Please rank the following combinations according to which you think you will like the most (1) and the least (6):

skim milk & half and half _____

skim milk & heavy cream _____

2% milk & half and half _____

2% milk & heavy cream _____

whole milk & half and half _____

whole milk & heavy cream _____

Which combination do you think your class will like the best?

Which combination do you think your class will like the least?

Name _____

Ice Cream in a Bag Taste Test Survey

As you taste each sample of ice cream, please rate the sample according to flavor, texture, color, and creaminess on a scale of 1-10 with 10 meaning most favorable and 1 meaning least favorable.

Note: Texture refers to how it feels in a person's mouth and may be used to evaluate how smooth or gritty, how watery or creamy, and how rich the sample is.

1 - least favorable 10 - most favorable

Sample	Flavor	Texture	Color	Creaminess
A				
B				
C				
D				
E				
F				

After tasting and rating all six samples of ice cream, please rank each sample according to which sample you liked the best and least.

Sample	Rank (1-liked the best; 6-liked the least)
A	_____
B	_____
C	_____
D	_____
E	_____
F	_____

Name _____

The Science of Why it Freezes Worksheet

1. At what temperature does water freeze?

2. Will the ice cream mixture freeze at the same temperature as water? Why or why not?

3. Will putting the ice cream mixture in plain ice get cold enough to freeze the mixture? Why or why not?

4. Explain the role of the rock salt used in making ice cream?

The Science of Why it Freezes ANSWER KEY

1. At what temperature does water freeze?

   At or below 0 degrees Celsius or 32 degrees Fahrenheit.

2. Will the ice cream mixture freeze at the same temperature as water? Why or why not?

   No, because the milk is composed of dissolved substances and other substances suspended in water that interfere with the water molecules forming a regular repeating pattern.

3. Will putting the ice cream mixture in plain ice get cold enough to freeze the mixture? Why or why not?

   No, because the plain ice will melt at 0 degrees Celsius (32 degrees Fahrenheit), which means that the ice will tend to stay around 0 degrees Celsius (32 degrees Fahrenheit).

4. Explain the role of the rock salt used in making ice cream?

   The rock salt lowers the freezing point of ice/water. For instance, a 10% salt solution freezes at –6 degrees Celsius or 20 degrees Fahrenheit. The salt mixed with the ice creates a solution that has a temperature lower than 0 degrees Celsius (32 degrees Fahrenheit). It takes energy for the salt to break into tiny particles that can dissolve in the ice water. The heat energy is transferred from the ice cream mixture through the plastic bag to the salty ice water causing the ice cream mixture to freeze and the ice to melt.

Ice Cream Experiment Samples and Fat Content

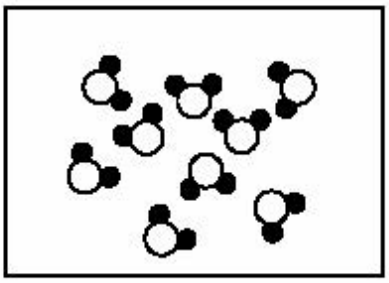
Combinations used in each sample:

- Sample A: skim milk & half and half
- Sample B: whole milk & heavy cream
- Sample C: 2% milk & half and half
- Sample D: skim milk & heavy cream
- Sample E: whole milk & half and half
- Sample F: 2% milk and heavy cream

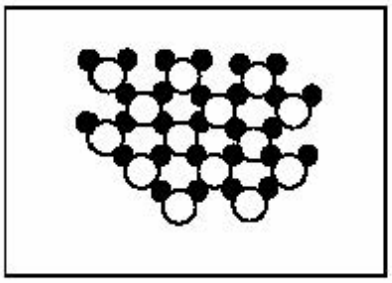
The following table shows the fat content of the dairy ingredients as well as the combinations of those ingredients used to make different samples of ice cream.

Type of Milk vs. Type of Cream	**HALF AND HALF (24g of fat in 1 cup)**	**HEAVY CREAM (80g of fat in 1 cup)**
SKIM MILK (0g of fat in 1 cup) [defined as milk containing less than 0.5% lipids (fat)]	24 g of fat / 5 servings = 4.8 g of fat per serving	80 g of fat / 5 servings = 16.0 g of fat per serving
2% MILK (5g of fat in 1 cup) [defined as milk containing 2% lipids (fat)]	29 g of fat / 5 servings = 5.8 g of fat per serving	85 g of fat / 5 servings = 17.0 g of fat per serving
WHOLE MILK (8g of fat in 1 cup) [defined as milk containing at least 3.25% lipids (fat) & 8.25% nonfat milk solids]	32 g of fat / 5 servings = 6.4 g of fat per serving	88 g of fat / 5 servings = 17.6 g of fat per serving

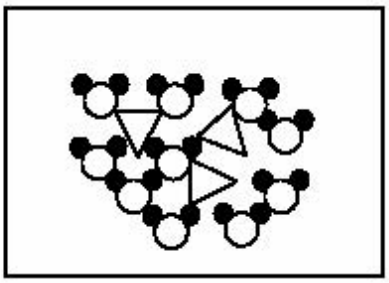
Molecular Composition of Water



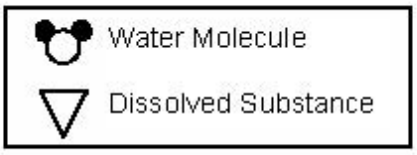
Liquid Water



Solid Water (Ice)



Water with Dissolved Substances at 0° Centigrade



Symbol Key