



**Lesson:** The Science of Dairy Products Processing -- Ice Cream

**Objectives:** The students will be able to:

- Identify the ingredients of ice cream
- Describe the attributes of a quality ice cream
- Define the colloidal state of ice cream
- Formulate ice cream with low milk fat
- Explain the use of salt in ice cream making
- Perform quantitative tests to determine quality ice cream
- Perform qualitative tests to determine quality ice cream
- To identify the procedure for making ice cream

**Science Concepts:**

Volume measurement, mass measurement, qualitative and quantitative measurement, lab procedures, density, weight measurement, fat content, suspension, colloids, taste, texture, temperature measurement.

**Time:**

Classroom: 2 hours

Laboratory: 2 hours

**Equipment and supplies you will need are as follows:**

- |                         |                                |
|-------------------------|--------------------------------|
| 1% milk                 | ½ gallon expensive ice cream   |
| 2% milk                 | ½ gallon inexpensive ice cream |
| whole milk              | 3 oz of vanilla extract        |
| cream                   | Half and Half                  |
| sugar                   | cooking pots                   |
| metal spoons            | 2 bags crushed ice per churn   |
| foam rubber             | measuring cups                 |
| measuring spoons        | plastic spoons for sampling    |
| small bowls for tasting | vegetable oil                  |

\* Dairy Lesson supported by a grant from the Massachusetts Dairy Promotion Board

Submitted by Danielle Melino, Mt. Everett High School





dish detergent

table salt

small cups for tasting

ice cream salt

paper towels

small dixie cups for taste test

Canned condensed milk with Carrageenan (optional)

### Teaching Procedure:

1. **Mental Set:** Present a piece of foam rubber to the class.

Ask in what way the foam is similar to ice cream?

*(Answer later)*

Tell them that you have noticed that cheap ice cream makes you burp a lot more than more expensive brands of ice cream. Why?

*(Answer later)*

2. What are the ingredients of homemade ice cream? Let students name them, list on board, then talk about each.

*Milk, Half & Half, Cream, Sugar, Flavorings, Air, Eggs, emulsifiers, stabilizers*

**Milk** - 1%, 2%, or whole milk at about 4% milk fat.

**Cream** - percent of milk fat may vary, up to 30 to 40%

**Half and Half** - contains no less than 10% milk fat

**Flavoring** - fruits, vanilla extract, etc

**Sugar** - Why does ice cream contain so much sugar?

When melted the mixture tastes too sweet. Why?

Show overhead of taste buds

*The coldness of ice cream numbs the taste buds, diminishing their sensitivity. In order to make the ice cream taste sweet the*

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*producer must add twice the sugar it would require if eaten at room temperature.*

Have you ever noticed when some people eat ice cream they wait until it gets soupy before eating it? Why? *It's sweeter tasting that way -- not as cold.*

How does sugar effect the freezing point of ice cream?

*It lowers the freezing point.*

How does sugar help preserve ice cream?

*Milk products are a perfect food for bacteria. The sugar helps preserve it in the same way it does jellies and jams.*

**Air** - How is air added to ice cream? *By churning, mixing with air. That's the reason if you put in 2 quarts of mix you get a yield of, perhaps 3 quarts.*

What happens if air is not added? *If mix is simple put in freezer it will be one big, hard chunk of ice.*

The more air you add the greater the yield.

What do you think cheap ice cream makers do? *They add a lot of air -- causing "overrun". Some overrun is 150%.*

How do you think cheap and expensive ice creams will compare in overrun? *Expensive will have less overrun. Homemade ice cream has just the right amount of overrun.*

How should inexpensive ice creams compare in weight with more expensive ice creams? *Expensive ice cream should weigh more.*

Show the students a half gallon of an inexpensive and a half gallon of expensive ice cream. Have one student weigh each container and record on board.

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**Activity:**

Provide students with cheap and expensive ice cream. Instruct them to carefully measure our equal volumes of each. Weigh each sample, then melt each sample in a water bath and measure the melted volume. Complete the chart below on the board.

Comparison of Weight of Ice Creams					
Groups ≡	1	2	3	4	Average of all Groups
Cheap Ice Cream					
Expensive Ice Cream					

Comparison of Volume of Melted Ice Creams					
Groups ≡	1	2	3	4	Average of all Groups
Cheap Ice Cream					
Expensive Ice Cream					

3. What are added ingredients of commercial ice creams? *Emulsifiers and stabilizers*

**Emulsifier** - to mix two liquids that do not mix well - fat and water in milk.

Large ice crystals will develop if not.

Seaweed - sea algae is used an emulsifier.

**Activity:**

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Mix cooking oil and water in a beaker before the class.  
Stir and show results.

Ask what can be added to emulsify these liquids? *Add detergent and stir.*

Show sample ice cream box with carrageenan *(an emulsifier from seaweed)*

**Stabilizer** - helps two food substances that do not mix well to mix and stay mixed. Air and milk in ice cream.

Gelatin is used as a stabilizer. Where does gelatin come from?

*From the bone, skin, cartilage and connective tissue of animals.  
Gelatin is the gummy Jell-O type stuff that in a pot of cooked meat.*

Show ice cream box lid with cellulose gel as a stabilizer.  
Stabilizers used to extreme in cheap ice cream to hide high volume of air.

4. What is the physical state of a air (gas) and milk (solid) called -- what is the colligative properties? *A colloid. A colloid is a dispersion on one material in another.*

How is a colloid different from a suspension? *Materials in a suspension settle out.*

Ice Cream and air is a solid foam colloid. Show foam used at beginning of class.

Ask how bread, ice cream and rubber foam are all alike?  
*They have air intersperse with solid matter in a stable mix (as long as ice cream is frozen).*

5. How does fat content effect the taste of ice cream?  
*Most people prefer high fat content.  
Generally - the higher the milk fat, the better it tastes*

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**Activity:** Blind milk fat taste test.

Allow students to taste for fat content in milk samples. Prepare 3 samples of milk in bathroom dispenser size white cups. Pour a few sips of 1%, 2% and whole milk (3.5+%) into sets of cups labeled X, Y, Z. If you put too much milk in the cup the students will be able to tell a difference in color. Let them guess which is which by raising their hands. Put the following grid on the board and record.

Class Identification of Milks With Varying % Milk Fat			
	X	Y	Z
1%			
2%			
Whole Milk			

Reveal the key to the above exercise and ask students to generalize about taste and fat content.

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6. What is the fat content of ice cream?

Demo one of the following problems on the board and assign the next for students to work, then review. The Pearson square can also be used. You will need the following fat contents:

Fat Content	
Whole Milk	4%
2% Milk	2%
1% Milk	1%
Half & Half	10%
Whipping Cream	30%

Example 1: recipe containing 2 cups of whole milk and 4 cups of cream.

$$\begin{aligned}(2 \text{ cups} \times 0.04\%) + (4 \text{ cups} \times .3) &= 6 \text{ cups } Y \\ .08 + 1.2 &= 6Y \\ .21 &= y \\ \text{Fat} &= 21\%\end{aligned}$$

Example 2: recipe containing 2 cups of 2% milk and 4 cups of Half & Half.

$$\begin{aligned}(3 \text{ cups} \times .04\%) + (4 \text{ cups} \times .1) &= 7 \text{ cups } Y \\ .12 + .4 &= 7Y \\ .07 &= y \\ \text{Fat} &= 7.4\%\end{aligned}$$

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Ask the class what the problem is with high fat ice cream? *Health!*

Ask the class how the fat content can be reduced?

*By substituting in lower fat products such as 2% milk for whole milk.*

### 7. The churning process:

What is the purpose of churning? *To whip in air as it freezes.*

What is needed? *Ice, salt and churn (electric or hand crank)*

How can the ice at 32 degrees freeze ice cream?

*The salt lowers the freezing point of the ice. As ice melts, heat is absorbed.*

*The heat from the ice cream contents is transferred to the ice mixture, allowing the ice cream to freeze.*

**Activity:** Have the students in small groups prepare two small cups of crushed ice. Insert a thermometer in each. Pour 2 tablespoons of salt on top of one. Pour about 1/4 cup of water over each. Record the temperatures on the board as shown below.

Comparison of Temperature of Melting Ice With and Without Salt			
	Beginning	After 5 Minutes	After 10 Minutes
Plain Ice			
Ice with Salt			

### 8. **Activity:** Ice cream recipes

Make 3 churns for three groups.

Assign each group a recipe.

Use the vanilla recipe as printed.

On the second recipe substitute Half & Half for the cream.

On the third recipe, substitute 1% milk for the whole milk and Half & Half for the cream.

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Prepare a blind taste test for the three recipes.

Allow the students to taste small amounts of each ice cream labeled A, B, C. Put the grid below on an overhead or on the board and record the groups vote for which they liked best as they raise their hands.

*You may want to have one group substitute in canned condensed milk with carrageenan to demonstrate the emulsifier and stabilizer effect of carrageenan.*

Class Preference of Ice Creams With Varying Percent of Milk Fat			
	A	B	C
Like Best			
Second Best			
Least Preferred			
<b>Tally</b> -- give 1 point for every 1st place vote, 2 for every 2nd place and 3 for every 3rd place. Low score wins.			

Is there any correlation between fat content and preference?

9. **Summary:**

Review the important points

10. **Evaluation:**

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Additional activity on bag ice cream:

## Plastic Bag Ice Cream

### Teachers Note

Ice cream freezes at -6 degrees C (21 degrees F). Ice cream can be made in the classroom with the understanding that the freezing point of water is actually 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.

A **marketing** activity can be done in conjunction with the production of the ice cream. As the students mix their ingredients, have them place one to two drops of food coloring in the bag. By changing the color of the ice cream, students can produce several varieties of the same product. The difference should only be in appearance. Have a group of people who do not know about the activity taste the different colored ice creams. Have the taste testers rank the ice cream from their favorite to their least favorite. This activity will illustrate how appearance is an important factor in marketing a product.

### Activity 1

#### Materials Needed (per group of 4)

1/4 cup sugar  
1 cup 2% milk  
1 cup whipping cream  
1/2 tsp. vanilla  
1 gallon Ziplock freezer bag  
1 quart Ziplock freezer bag  
4 plastic spoons  
4 small paper cups  
measuring cup  
measuring spoon  
piece of strong tape (masking, duct, etc)  
2 cloth towels or mitts

#### Teacher's Materials (per class of 24)

1 2lb. bag sugar  
1 gallon 2 % milk  
3 pints whipping cream  
1 small bottle vanilla  
1 box gallon Ziplock freezer bags  
1 box quart Ziplock freezer bags  
1 box plastic spoons  
1 box small paper cups  
6 measuring cups  
6 measuring spoons  
roll of strong tape  
12 cloth towels or mitts

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½ bag of prepared ice  
¾ cup of water  
1 cup rock salt

3 bags prepared ice  
4 ½ cups of water  
1 bag rock salt

**For groups of 2**

substitute sandwich bags for gallon size Ziplock bags



## Activity 2

same materials needed as above  
food coloring

### Alternative Procedure Ingredients (per group of 2)

1/8 cup sugar  
1/2 cup 2% milk  
1/2 cup whipping cream  
1/4 tsp. vanilla  
1 quart Ziplock freezer bag  
2 small sandwich bags  
2 plastic spoons  
2 small paper cups  
measuring cup  
measuring spoon  
2 pieces of strong tape  
2 cloth towels or mitts  
1/4 cup water  
1/2 cup ice  
1/2 cup rock salt



**Procedure** (per group of 4)

1. Setting up the milk, whipping cream, vanilla, and sugar in an assembly line process for students to access reduces classroom congestion.
2. Add 1 cup milk, 1 cup whipping cream, 1/4 cup sugar (4 tablespoons), and 1/2 teaspoon vanilla to a 1 quart Ziplock freezer bag for each group and tightly seal. Use a piece of duct tape to seal the Ziplock end of the bag. For activity 2, add different food colorings to the ice cream ingredients in each group.
3. Students place the quart Ziplock bag with the ice cream ingredients inside a 1-gallon zip lock bag. Pack ice around the small bag and add the rock salt and 3/4 cup of water. The gallon bag should then be tightly sealed using the duct tape.
4. Students should shake or toss the bags between their hands while protecting them with cloth towels or hot /cold mitts. This should be done until you can see that the ice cream is frozen (it will pull away from the sides of the inner Ziplock bag). The entire process takes about 10 minutes.
5. The outer bag can then be opened by each group and the ice and salt discarded. Rinse the bag containing ice cream prior to dividing the ice cream into sundae cups for the students to eat. Use the wooden spoon to serve the ice cream.
6. Eat the ice cream plain or with your favorite toppings and enjoy.  
**Caution: Students who are allergic to milk or milk products should not eat the ice cream.**
7. For activity 2, have the students taste the different colors of ice cream and chart their preferences (see sample chart). Lead a discussion about how consumer perceptions drive consumer choices.
8. Clean up all laboratory equipment and discard paper sundae cups and plastic spoons.



### **Alternative Procedure** (per group of 2)

1. Setting up the milk, whipping cream, vanilla, and sugar in an assembly line process for students to access reduces classroom congestion.
2. Add 1/2 cup milk, 1/2 cup whipping cream, 1/8 cup sugar (2 tablespoons), and 1/4 teaspoon vanilla to a small sandwich bag for each group. Mix the ingredients and then pour half of the mixture into your partner's bag. Use a piece of duct tape to seal the ends of the sandwich bags. For activity 2, add different food colorings to the ice cream ingredients in each group.
3. Place the bags with the ice cream ingredients inside a 1-quart zip lock bag. Pack ice around the small bags and add the rock salt and 1/2 cup of water. The quart bag should then be tightly sealed using the duct tape.
4. Students should shake or toss the bags between their hands while protecting them with cloth towels or hot /cold mitts. This should be done until you can see that the ice cream is frozen (it will pull away from the sides of the inner Ziplock bag). The entire process takes about 10 minutes.
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Sample Chart for Activity Two:

### Taste Test Tally

Ask each taste tester to rank the samples from the best (1) to the worst. Add the numbers from left to right and enter in the total column. After you total each sample\*s score you can rank them. The lowest score was the most preferred and the highest number is the least preferred.

	<b>Taste Tester 1</b>	<b>Taste Tester 2</b>	<b>Taste Tester 3</b>	<b>Taste Tester 4</b>	<b>Total</b>	<b>Final Ranking</b>
<b>Sample A</b>						
<b>Sample B</b>						
<b>Sample C</b>						
<b>Sample D</b>						
<b>Sample E</b>						
<b>Sample F</b>						

Conclusion: